Concrete

Vol. 33 Chicago, July, 1928 No. 1

Speed with Economy in High Early Strength Concrete

Using Standard Portland Cement, Standard Control Methods and a 1:2:4 Specification, High Early Strength Concrete Was Secured Under Winter Conditions—Only One Set of Forms Required—Forms Removed in Four Days—Plant Layout and Job Methods—All Materials Measured by Weight—Cost of Control Methods

By JOHN G. AHLERS
Secretary-Treasurer, Barney-Ahlers Construction Corporation, New York

IN the period from February 17th to April 16th, seven decks were placed over a three-story warehouse built two years ago and designed to carry the additional floors. This record was done with one set of forms and concrete of 1:2:4 mix. By the use of modern water-ratio control methods a high early strength was obtained and speed hence was maintained. A good plant was installed and sufficient cold weather protection was provided. A study was made of the cost of such items as would not occur under the old methods, and an analysis shows that these expenditures were well worth while, and in the end accomplished a saving on the total cost of the work.

SOME of Mr. Ahler's conclusions from the job described in this article are:

1—Assurance of the quality of the concrete is best obtained by weighing the water, cement and aggregates.

2—Compressive strength of 2300 lbs. per sq. in. with a water-cement ratio of 1.00 can be expected from 1:2:4 concrete in New York City.

3—Control methods pay for themselves even though increased strength is not taken advantage of in the design.

4—The concrete industry can safely adopt the proposed American Concrete Institute Building Code and Standard Designs.

A Rush Job

The warehouse is for the R. H. Macy Company, the largest department store in New York City, and is one of a series of additions which have been constructed by the Barney-Ahlers Construction Corporation for over a period of years, under the supervision of the owner's architects, Robert D. Kohn, F. A. I. A., Frank H. Holden, A. I. A., and John J. Knight, and consulting engineer, E. W. Stern. Soon after the first of the year, R. H. Macy Company found itself with increased business, warehouses filled and with a large stock of spring goods moving in, also summer supplies such as canoes, wicker furniture, etc., coming in in April, so that immediate expansion of the warehouse was desirable.

The work was authorized early in February, but not until the 17th was it possible to really start the job. Everything, in the meantime, was carefully scheduled and planned. As soon as the work had been authorized, it immediately became a race to give storage facilities by April 15th on some of the new floors, in order that goods that had been bought for delivery in April might be housed and not left for a length of time on demurrage in railroad cars.

On April 15th the first of these goods began moving in on the sixth floor, the upper floors having been waterproofed and the roof concreted so that no moisture came down through the building. Sides on four floors were entirely enclosed and door connections made to the adjacent old warehouse.

The three-story foundation for the addition being already in place, start of construction work involved merely removal of the terra cotta column caps on the temporary roof. A prompt start could be made in placing concrete as soon as these forms were in place. No openings were made until the day previous to concreting. They were then covered very carefully with canvas. As soon as column forms could be removed, temporary waterproofing was placed around each and joined to old roofing. Hence the lower three floors were safe throughout, only a few drops of moisture coming in even in heavy rainstorms. The old roof was not removed until the new roof was weathertight.

A 1:2:4 Mix Specified

The conditions set forth by the architects and engineers in their specifications were that a 1:2:4 mix should be used regardless of the strength that might be obtained from such proportions. It was natural, therefore, that an effort would be made to produce concrete of the highest possible strength, and of the highest possible yield. By making concrete of a high strength it would be possible to proceed with winter construction at a rapid pace and reasonable cost. By good grading of fine and coarse aggregates a high yield in concrete could be obtained with consequent low material cost factors. The specifications, furthermore, encouraged a minimum amount of water to be used in the 1:2:4 mix. As this was identical with the desire for high strength, special attention was paid to the possibility of using concrete of driest practical consistency still having fair workability by exact control of the water-cement ratio. These problems were fully realized, studied and solved in connection with the plant layout.

Plant Layout

The supply of aggregate consisted of very large storage piles in the dealer's yard, within 5 minutes' haul from the job. It was therefore considered desirable to have a minimum amount of storage on the job and to take truckload delivery. After a study and cost analysis of several layouts, the plant installation decided on was a ramp to a bin of 30 yds. capacity. This would enable the plant to keep working for a half hour during any possible breakdown of delivery. As a matter of fact, the longest shutdown, due to failure of the trucking supply, was not in excess of 15 minutes.

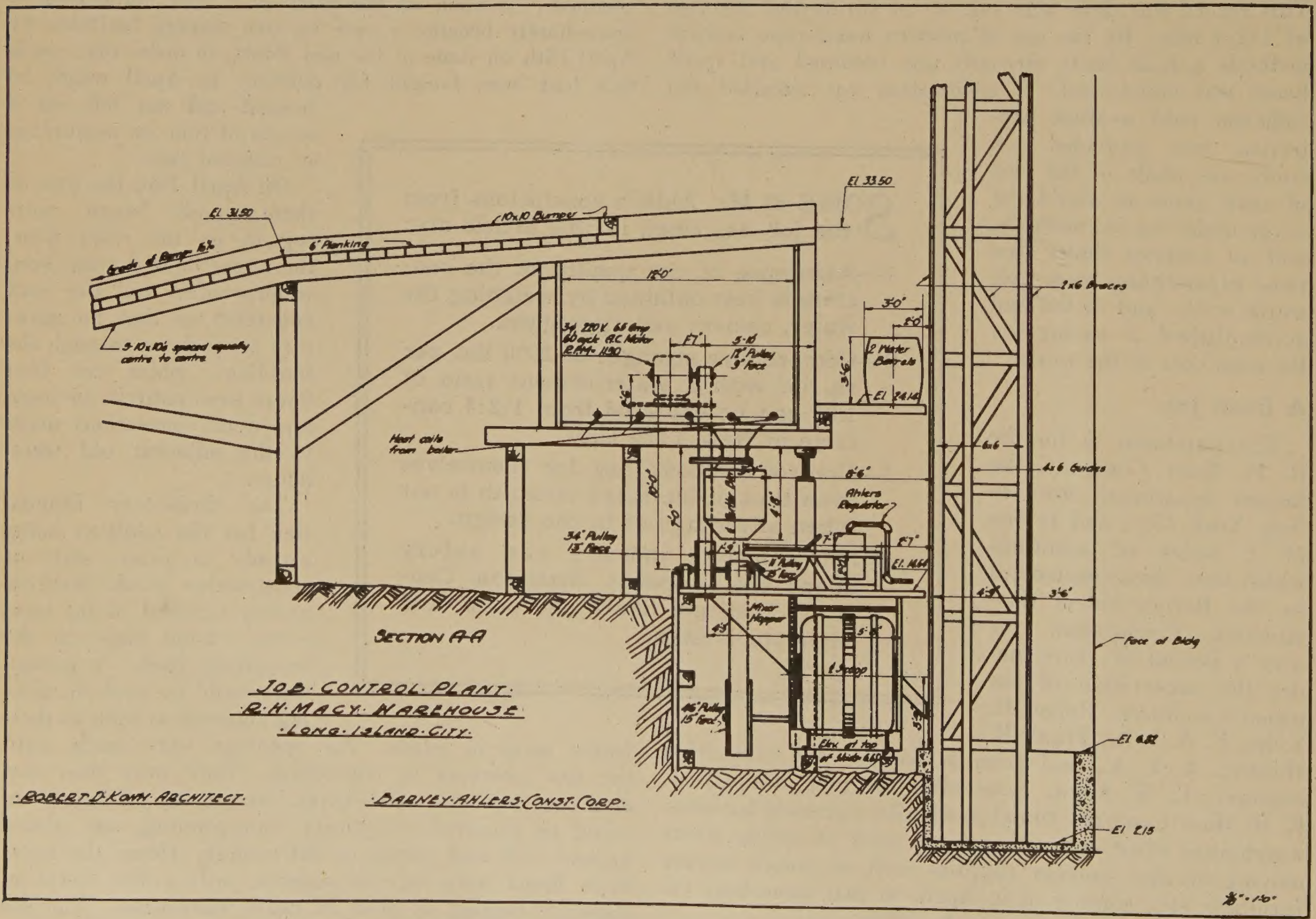
It was necessary to build a ramp of considerable length, as shown in the picture, in order to give the trucks sufficient grade to back up easily. A truckload was required every 5 minutes to give a one-yard batch per minute, and there was never any difficulty about the going up and down of the ramp as long as the trucks were at the job when wanted.

The cross-section of the plant shows the layout and indicates the height required in order to work by gravity as far as possible. As proportions were fixed and uniformity in strength was wanted, it was decided that it would be desirable to weigh all the different materials in the concrete.

An installation was therefore made of a combined volume and weighing hopper, this being obtained from the Butler Bin Company and requiring only a 7-ft. headroom above the mixer platform. It was likewise decided to install a concrete strength regulator which automatically weighs a batch of cement against each batch of water, giving a constant and absolute water-cement ratio.

Cold Weather Provisions

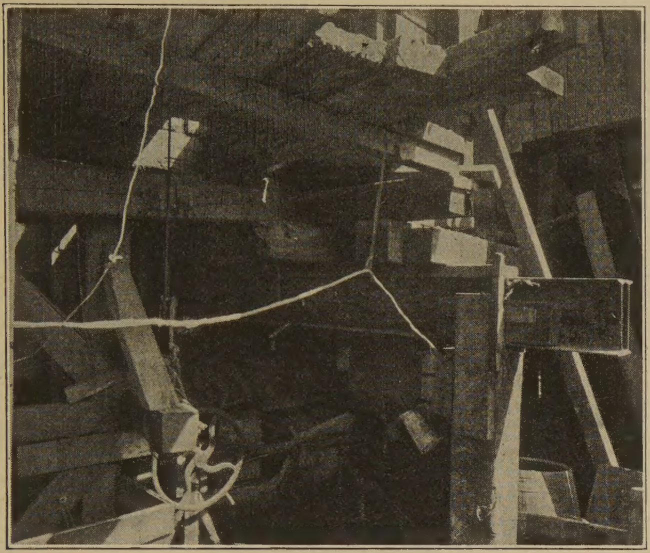
Steam coils were installed at the bottom of the bin to maintain the aggregates at the highest possible temperature. Likewise a live steam pipe was run into a double water reservoir set above the mixer platform so as to give a large supply of hot water directly at the concrete strength regulator. An interesting sidelight on this job is the fact that with the live steam injected into the aggre-



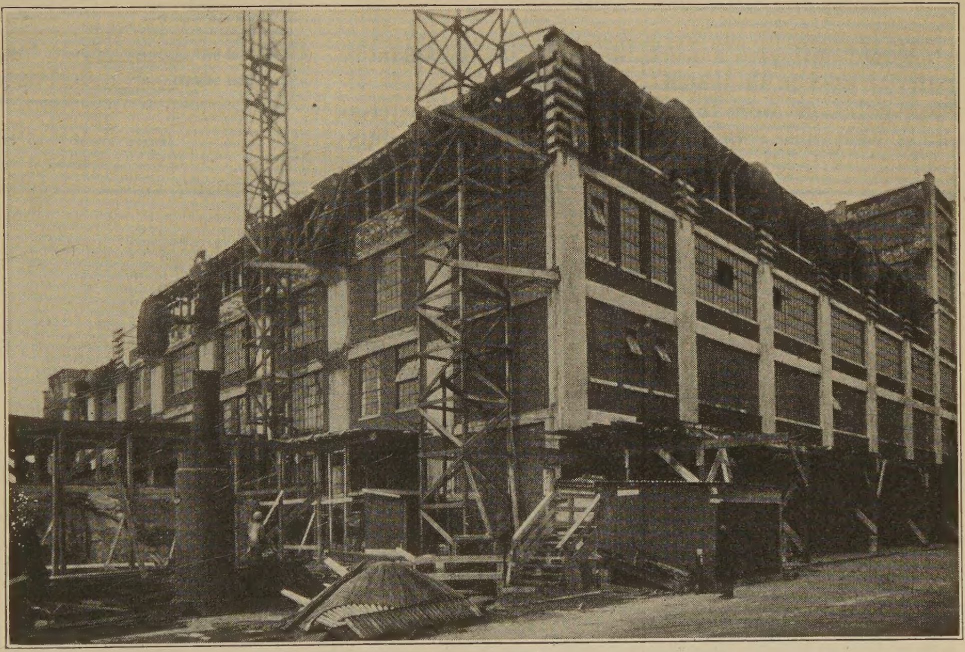
Sketch of job control plant layout

gate, the moisture content was fairly constant throughout the job.

An ordinary brand of cement was selected that had given good strength results on much previous work and rapid delivery and service from the mill had been obtained in the past. All mill tests showed that this cement complied with the A. S. T. M. standard and gave a strength in excess of 2000 lbs. with a water-cement ratio of "one," using the aggregates available in the New York territory.



Close-up of the control equipment, showing the measuring hoppers and the strength regulator



The job in winter. At the left is the concrete plant

In other words, from previous use it was reasonably safe to assume that this cement would give a curve whose equation would be S equals $\frac{14000}{6.0x}$, or a strength of about 2250 to 2300 lbs. at 28 days, using a water-cement ratio of "one."

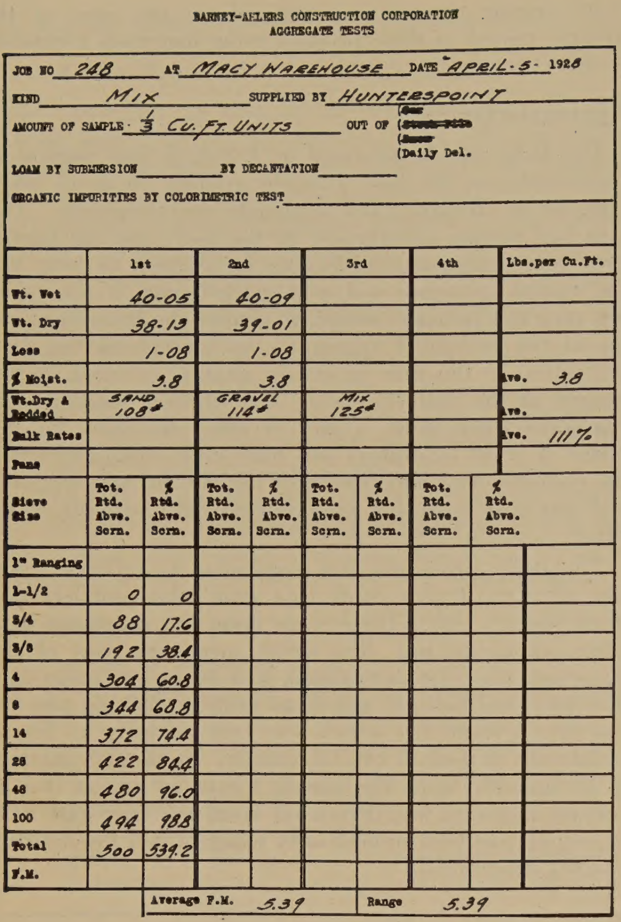
It would be of great help to engineers and contractors if all cement companies could inform the users of the strength curves of their product using materials available, in other words, job curves.

Aggregate Grading

The field mix being fixed at 1:2:4, it was natural to concentrate on the best possible grading so as to get a high yield. Ready-mixed aggregate was available. This also had proven satisfactory in the past, and the supply yard being adjacent and having large stock of both fine and coarse aggregate and well graded sand, it was possible, on a few minutes' notice, to change the fineness modulus of the combined aggregates by merely adding fixed quantities of the fine or coarse gravel, or sand, to the hopper at the delivery yard. The fineness modulus was computed three times a day in order to check on this phase. A small laboratory was built under the ramp where the engineer who had charge of the control was stationed and was able to do his work immediately adjacent to the plant.

The daily procedure was somewhat as follows. Samples of a third of a cubic foot were taken not less than three times a day. These were from the aggregate as it came out of the bin. The weight per cubic foot of this aggregate was first determined, thereupon 500 gram samples were weighed off, put in an ordinary baking pan and put over a small fire which was kept going in an improvised oven outside of the laboratory. In about 5 minutes' to 10 minutes' time, the sample would be dry so that all surplus moisture was driven off from the aggregate. The aggregate was then immediately weighed and the moisture content determined.

The aggregate was thereupon tested in Tyler sieves for fineness modulus and proportion of fine to coarse. A check on the weight of a dry rodded volume was made. As soon as this information was available any necessary adjustment in the weighing hopper was made and any necessary adjustment on the moisture compensating weight on the concrete strength regulator was made. The water-cement ratio was kept fixed at a point as low as possible



BARNEY-AHLERS CONSTRUCTION CORPORATION
AGGREGATE TESTS

JOB NO 248 AT MACY WAREHOUSE DATE APRIL-5- 1928
KIND MIX SUPPLIED BY HUNTERSPOINT
AMOUNT OF SAMPLE $\frac{1}{3}$ CU. FT. UNITS OUT OF (~~[illegible]~~ (~~[illegible]~~ (~~[illegible]~~ (Daily Del.
LOAM BY SUBMERSION ______ BY DECANTATION ______
ORGANIC IMPURITIES BY COLORIMETRIC TEST ______

	1st	2nd	3rd	4th	Lbs.per Cu.Ft.
Wt. Wet	40-05	40-09			
Wt. Dry	38-13	39-01			
Loss	1-08	1-08			
% Moist.	3.8	3.8			Ave. 3.8
Wt.Dry & Rodded	SAND 108#	GRAVEL 114#	MIX 125#		Ave.
Bulk Rates					Ave. 111%
Fane					

Sieve Size	Tot. Rtd. Abve. Scrn.	% Rtd. Abve. Scrn.	Tot. Rtd. Abve. Scrn.	% Rtd. Abve. Scrn.	Tot. Rtd. Abve. Scrn.	% Rtd. Abve. Scrn.	Tot. Rtd. Abve. Scrn.	% Rtd. Abve. Scrn.
1" Ranging								
1-1/2	0	0						
3/4	88	17.6						
3/8	192	38.4						
4	304	60.8						
8	344	68.8						
14	372	74.4						
28	422	84.4						
48	480	96.0						
100	494	98.8						
Total	500	539.2						
F.M.								

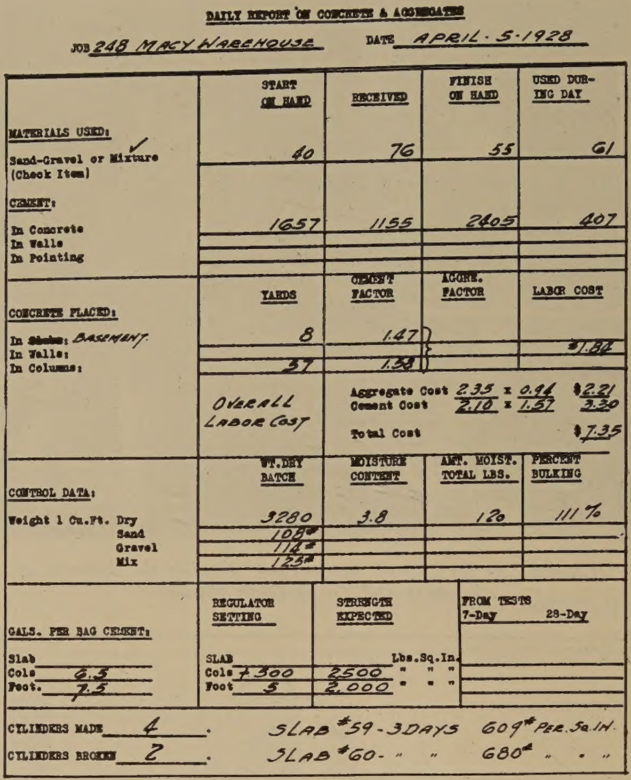
Average F.M. 5.39 Range 5.39

Aggregate test report form

which would still give a workable mix with the quantity of material used in the batch.

The conclusions were that in the better graded material the mass was more compact (less voids), but more bulking, whereas in the poorly graded material the mass was less compact (more voids), but there was also less bulking. The one tended to compensate for the other so that the conclusion from this large operation is that by using weight measurement an absolutely certain method of keeping the concrete constant can be said to have been found. The daily records have been compiled on a table which is shown herewith. These daily reports were made to the

(Continued on page 46)



DAILY REPORT ON CONCRETE & AGGREGATES

JOB 248 MACY WAREHOUSE DATE APRIL·5·1928

	START ON HAND	RECEIVED	FINISH ON HAND	USED DURING DAY
MATERIALS USED: Sand-Gravel or Mixture ✓ (Check Item)	40	76	55	61
CEMENT: In Concrete	1657	1155	2405	407
In Walls				
In Pointing				

	YARDS	CEMENT FACTOR	AGGRE. FACTOR	LABOR COST
CONCRETE PLACED: In ~~[illegible]~~: BASEMENT	8	1.47		
In Walls:				$1.84
In Columns:	37	1.38		

OVERALL LABOR COST

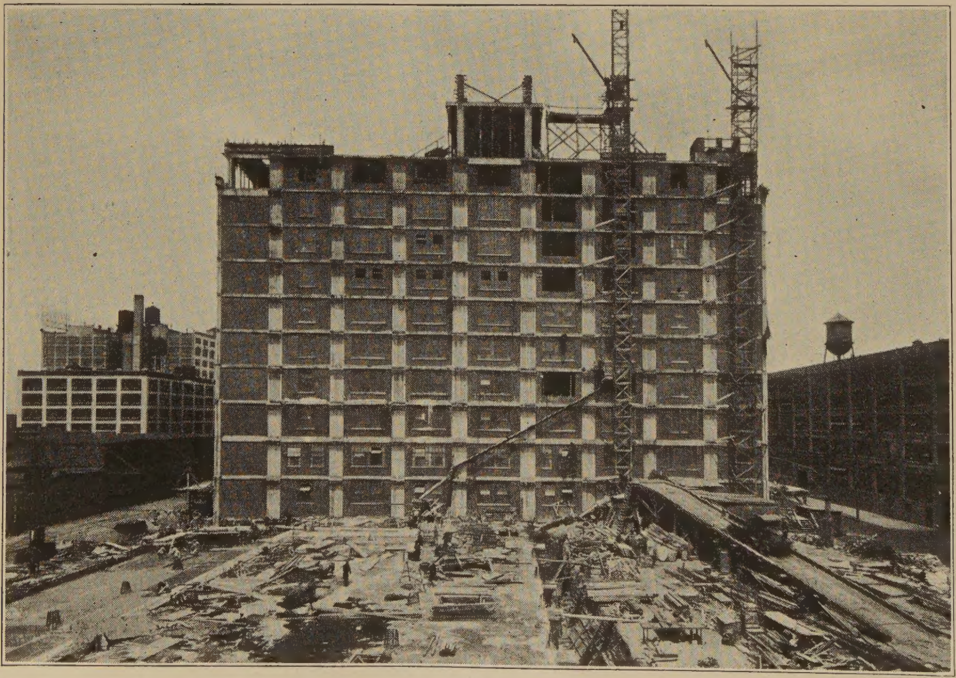
Aggregate Cost 2.35 x 0.94 $2.21
Cement Cost 2.10 x 1.57 3.30
Total Cost $7.35

	WT. DRY BATCH	MOISTURE CONTENT	AMT. MOIST. TOTAL LBS.	PERCENT BULKING
CONTROL DATA: Weight 1 Cu.Ft. Dry	3280	3.8	120	111%
Sand	108#			
Gravel	114#			
Mix	125#			

GALS. PER BAG CEMENT:	REGULATOR SETTING	STRENGTH EXPECTED	FROM TESTS 7-Day	28-Day
Slab	SLAB	Lbs.Sq.In.		
Cols 6.5	Cols 7.300	2500 " " "		
Foot. 7.5	Foot 5	2,000 " " "		

CYLINDERS MADE 4. SLAB #59-3 DAYS 609# PER. SQ.IN.
CYLINDERS BROKEN 2. SLAB #60- " " 680# " " "

Daily report on concrete and aggregates



The job under way. Note the inclined roadway over which aggregates were delivered

Curing Tunnel Design

Importance of Proper Curing—How Concrete Products "Cure"—Amount of Moisture Needed—Supplying the Moisture—Regulating the Temperature—Piping Arrangement—Size and Shape of Tunnels

By **W. D. M. ALLAN**
Manager, Cement Products Bureau, Portland Cement Association

WITHIN the last two months the writer has visited six large new plants either just completed or under construction where the requirements of curing were either not understood or the plants not designed to produce efficient curing. So much misinformation is going the rounds on how to cure concrete products that we are presenting herein what experience has shown to be the best practice to follow.

How Concrete Products "Cure"

An understanding of what happens when concrete products are put into steam curing rooms will help the manufacturer in laying out the most efficient curing system. A sack of cement requires from 3 to 3½ gallons of water for hydration and since practically all concrete block are made with five or more gallons per sack, there is an excess of water over what is actually needed for hydration. The purpose of curing is to maintain in the unit the water necessary for hydration rather than to add more water. At first hydration takes place rapidly and it is important that proper moisture and temperature conditions be provided.

The only way water can get out of the block is through evaporation. Air at any temperature can hold just so much moisture and if more is turned into it, the excess is precipitated on the ceiling, walls and floors in the form of drops of water. As soon as any moisture gathers on the ceiling or the air becomes slightly foggy throughout, sufficient water vapor is present. Enough moisture is enough and too much is a nuisance. Excess moisture escapes into the plant, making working conditions miserable and causing deterioration of the plant equipment and materials to say nothing of reducing the efficiency of the workmen through attacks of rheumatism and colds.

In the winter time it is sometimes impossible to see 3 feet ahead in some plants due to the fog from the curing tunnels. To remedy this condition various kinds of doors have been invented that are supposed to be air-tight. Ventilators are installed and a more recent practice is to separate the curing tunnels from the remainder of the plant by an enclosed runway. Each of these plans aims at remedying a condition that should not exist and can be better corrected at its source.

Supplying the Moisture

In an ordinary tunnel 8 feet wide and 60 feet long, two or three ⅛-inch petcocks attached to the steam line or two or three small fog nozzles will furnish more moisture than is necessary to keep the air saturated. Adjust the openings of the petcocks or fog nozzles so that the air is filled with fog but so that no moisture is liberated into the remainder of the plant. Air-tight doors are necessary to prevent the loss of heat but should not and need not be relied upon to prevent excess moisture from escaping into the plant.

The objection is raised that when curing room doors are open at the plant end to remove the products, the moisture then escapes into the plant. Consider that when the excess of moisture is not used there will be very little fog to escape. Further, the moisture should be shut off half an hour before the block are to be removed from the tunnels. There is no need for moisture escaping into the plant when the curing tunnels are open to remove the block, and if it does, the plant is not operating properly. So much for the regulation of moisture in the curing room and now for the regulation of heat.

Effect of Temperature

Heat and moisture should be controlled separately. Figure 1 shows the effect of heat on the early strength of the product. In all cases evaporation of moisture from the units was prevented. The temperature was varied. The highest early strength was obtained with a curing temperature of 212 degrees F., but it is recommended that 125 degrees F. be maintained as average. A more expensive type of curing room construction, as well as a much more proportionate amount of fuel, is necessary if a temperature of 200 degrees F. or more is maintained.

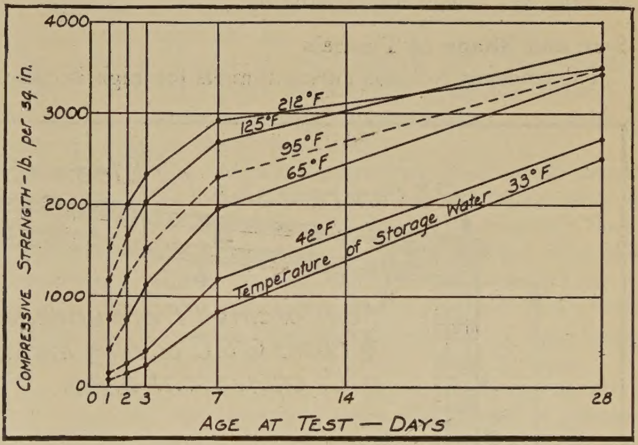


Figure 1

Figure 2 gives plans for piping the heat into the tunnel. Any radiation engineer can figure the exact amount of pipe surface necessary to get 125 degrees F. under given conditions. In general, four or six 2-inch pipes run the full length of the tunnel on either side close to the floor will be sufficient for a well-insulated tunnel with not more than 48 square feet of cross section. The headers to which the longitudinal radiation pipes are connected should be large enough and have additional connections so that more radiation can be added if necessary to maintain the desired temperature. Radiation should be placed close to the floor, the bottom pipe within 4 inches of it, to start the heat as low as possible. Sheets of galvanized iron should be placed about 2 inches from the outside of the radiation pipes to prevent the products directly opposite the pipes from drying out. This arrangement also helps to keep the heated air circulating.

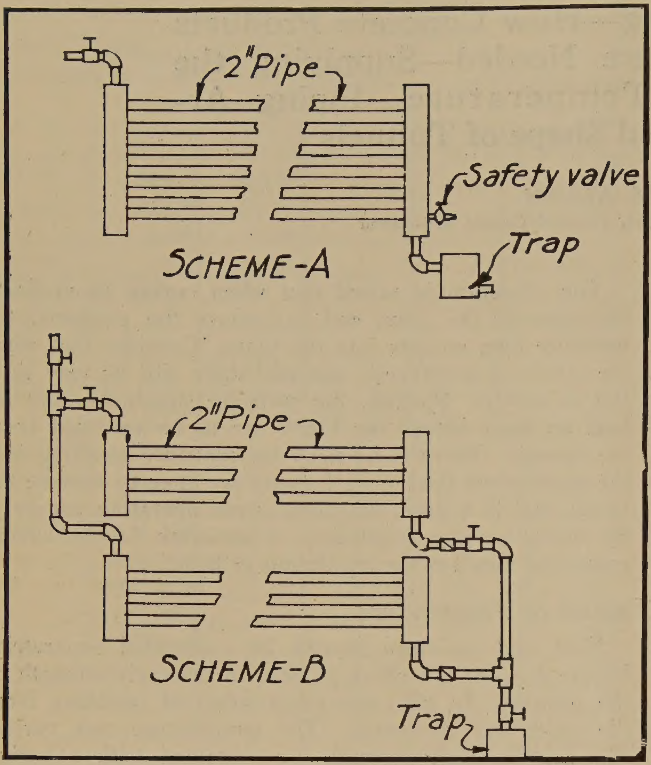


Figure 2

Size and Shape of Tunnels

The tendency to build curing tunnels too high is causing a considerable loss in heat. For maximum efficiency the tunnels should be so low that the average workman has to stoop while in them. A height of 6 feet 8 inches, as shown in Figure 3, should be the maximum. Tunnels 7½ to 8 feet high require twice the radiation to maintain the necessary temperature at the average block level as tunnels 5½ feet high do. Considering that in an efficient tunnel steam curing may cost ½ cent per block, in a high tunnel the cost will be 1 cent per block or a loss of ½ cent, which, when multiplied by 500,000 means an annual loss of over $2,000. If products men would figure what it costs to heat overhead space that has no value, many a tunnel would be lowered or a false roof put in.

Regulating Heat

A recent experience in a very well equipped plant prompts the following suggestions. Thermometers for registering the temperature of the tunnels should be suspended along the center line of the tunnel and lowered to a point about half way between the top and bottom rows of block on the racks. If placed near the top of the tunnel they register 40 to 50 degrees above the average temperature of the block, and if placed at the floor level, 20 or 30 degrees below the average temperature of the block. Automatic thermostats are best for regulating the heat but a reasonable degree of accuracy can be obtained by any foreman by occasionally referring to a thermometer properly placed in the tunnel.

Faulty design and layout cost many thousands of dollars loss annually to the industry. Much if not all of this could have been eliminated. It is particularly disappointing to find a plant where considerable money has been spent to obtain a layout that is positively less efficient than many less expensive plants. There are not many new ideas in the concrete products game that someone has not tried out. The Portland Cement Association has studied the efficiency of various plans and kept records which are available to all products men for the asking.

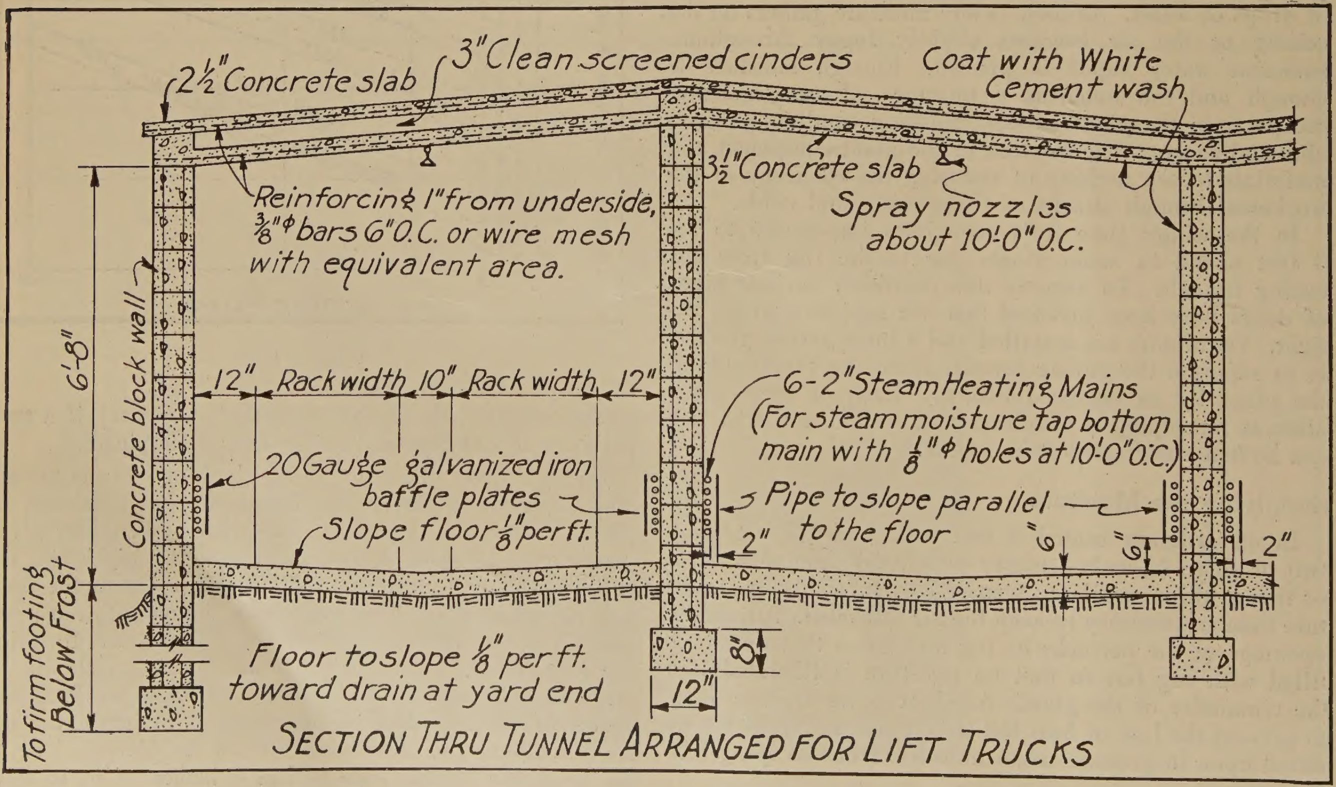
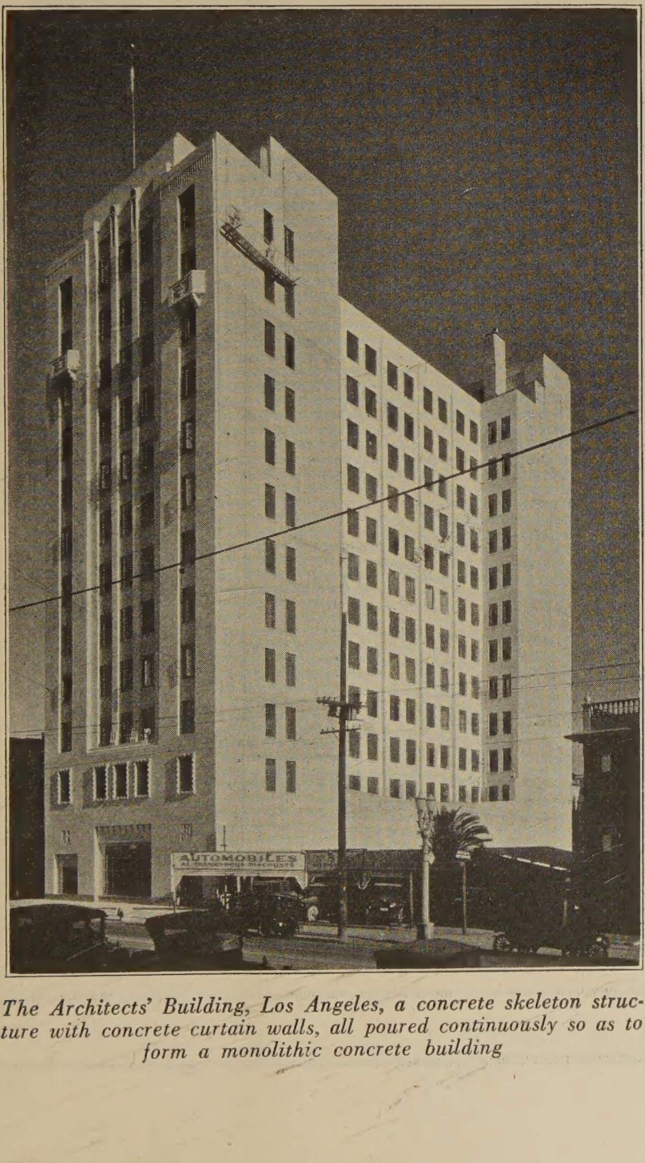

2½" Concrete slab
3" Clean screened cinders
Coat with White Cement wash
3½" Concrete slab
Spray nozzles about 10'-0" O.C.
Reinforcing 1" from underside, ⅜"φ bars 6" O.C. or wire mesh with equivalent area.
6'-8"
Concrete block wall
12"
Rack width
10"
Rack width
12"
20 Gauge galvanized iron baffle plates
Slope floor ⅛" per ft.
6-2" Steam Heating Mains (For steam moisture tap bottom main with ⅛"φ holes at 10'-0" O.C.)
Pipe to slope parallel to the floor
2"
6"
6"
2"
To firm footing Below Frost
Floor to slope ⅛" per ft. toward drain at yard end
8"
12"
SECTION THRU TUNNEL ARRANGED FOR LIFT TRUCKS

Figure 3

CONCRETE IN ARCHITECTURE

Architects' Building in Los Angeles is One of the Pacific Coast Buildings Where the Use of Reinforced Concrete Provides Bearing and Filler Walls as Well as the Structural Frame. The Rich Effect of Unadorned Monolithic Concrete Walls is Shown in the Illustrations

ONE of the early attempts to use concrete as a facing material for an office building in Los Angeles is embodied in the beautiful new Architects' building just completed in that city. The exterior walls of the structure are devoid of any facing material whatsoever except a waterproofing compound to which small portions of color have been added. All the ornaments on the building with the exception of one or two small pieces of stone over the main entrance are concrete cast with reverse plaster of Paris molds as forms.



The Architects' Building, Los Angeles, a concrete skeleton structure with concrete curtain walls, all poured continuously so as to form a monolithic concrete building

The building is Class "A" concrete skeleton construction with concrete filled walls, poured continuously with the structure, forming a monolithic mass. Every care was taken in the designing of the building to give the concrete structural frame as much earthquake resistance as practicable. The structural design was in charge of Paul Jeffers, who made an intensive study of the Santa Barbara earthquake and its results, and who has incorporated in this plan the methods he has devised to prevent destruction from the earth shocks.

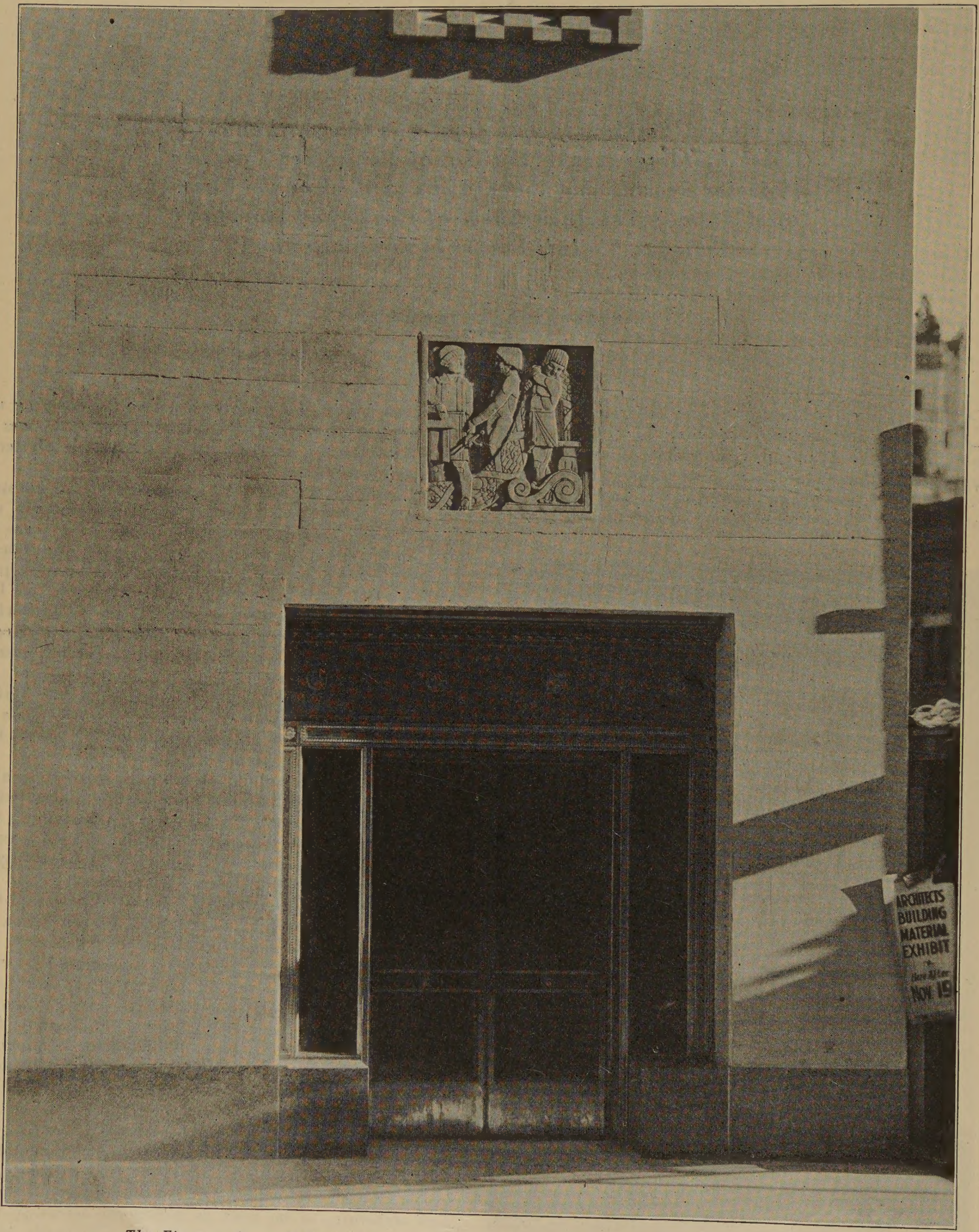
The exterior design of the building is in the vertical treatment and very plain, depending upon the mass for the architectual beauty. Slight suggestions of the set-back treatment now in vogue are used.

The decorations include ornamental iron work about the display windows and the first floor entrances, with a circular wrought iron stairway from the mezzanine floor to the basement. A piece of cast stone is used over the entrance on which have been hand carved several figures. The first floor elevator lobby has a marble floor with Botticine marble walls, vaulted coffered ceiling, and large display windows opening to the main exhibit room.

The building was constructed at the instance of Miss M. L. Schmidt, who fourteen years ago started a permanent building exhibit, one of the first of its kind in the country. Through her association with the architectural profession, she realized the need in Los Angeles for a building devoted entirely to its use. She interested members in the project, securing financial support from Preston S. Wright, and the building was started a short time ago. The basement, main floor, and mezzanine will be occupied by the Architect's Building Material Exhibit. The upper stories will contain the offices of prominent architects, structural engineers, surveyors, and allied lines.

The frame is so constructed that an additional floor or roof structure, to be used as a general assembly room, can be added. The parapet walls are sufficiently high to permit the erection of this future structure without altering the exterior walls of the building.

The upper stories are of loft construction, permitting the tenants to design special layouts for their office spaces.



The Figueroa Street Entrance, showing the monolithic concrete walls devoid of any facing material except a light coat of waterproofing compound

Cinder Block Ribbed Type Floor Slab Construction

How a Concrete Products Manufacturer Enlarged His Sales Through the Promotion of Concrete Floors

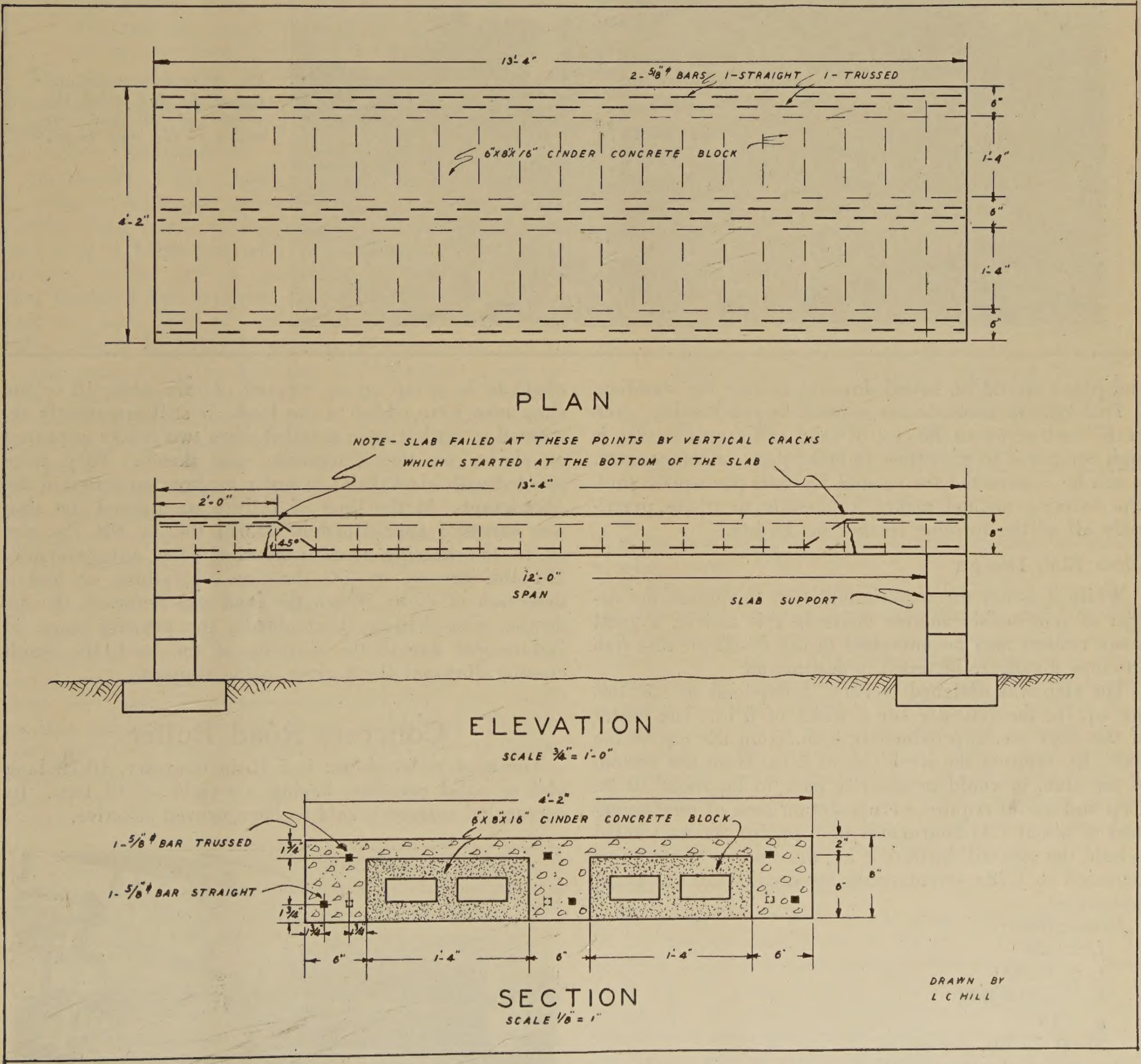
By L. C. HILL

THE slab shown in the accompanying sketch and photograph was constructed by the Jacksonville Concrete Products Co., of Jacksonville, Fla., for the purpose of promoting better floor construction for residential purposes. In promoting this type of floor and in conducting the test described later, an enlarged market for concrete masonry units was developed.

In Florida, as well as in other southern states, few houses are built with basements. As a rule they are built upon piers or with a well ventilated foundation wall to prevent dry rotting of the sills and floor joist.

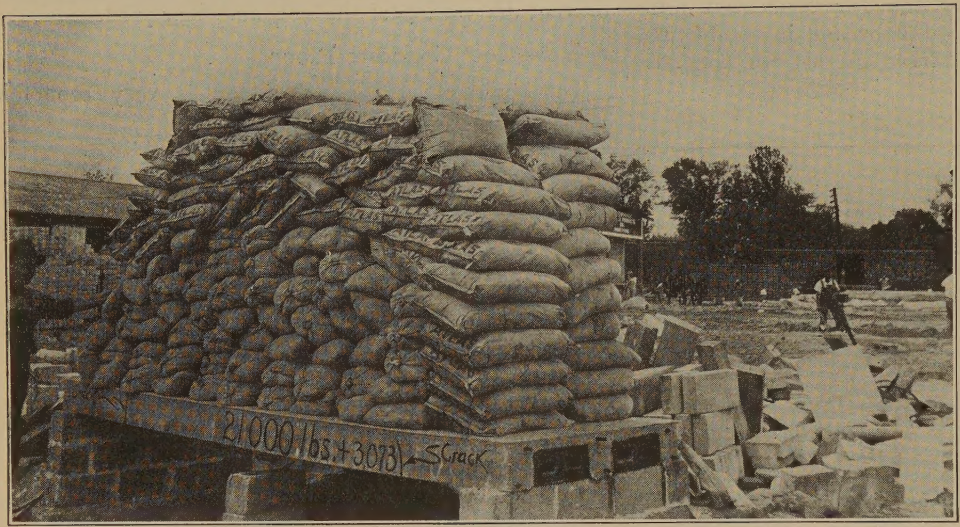
A Low-Cost Concrete Floor

This type of floor construction is very economical.



Sketch showing the design of the floor slab

Very little forming is required. In actual practice, the footing would be poured and the foundation wall laid up as shown. Then 2- by 8-in. timbers would be spaced 14 in. apart, flush with the top of the foundation wall and shored up. The cinder concrete block are then laid in a continuous row, having an inch bearing on each 2-by-8. A 6-in. space is left between the rows of block for the beam. The reinforcing bars are then placed and the slab poured. The surface or topping may be brought up to the finished floor level or brought up to a sufficient height to receive floor tiling. Also sleepers may be attached with clips and a wooden floor laid. If a masonry house is built, the wall proper would be started from the top of the slab. In a frame house, bolts would be imbedded around the outer edge and where the partitions are to be built, and plates would be bolted down to receive the studding.



The floor slab at failure. Before the slab failed, the weight of 18 men was added to the load shown

This type of construction is ideal in any locality, even in this section where the cost of sand and gravel or slag is high compared to the prices in other parts of the country. It can be constructed for around 55 cents per square foot. The forming method makes it possible to re-use practically all of the forming lumber in the job.

Floor Slab Design

While it is not the writer's intention to discuss the design of reinforced concrete floors in this article, a great many readers may be interested in the design of this slab and how it came to be tested to destruction.

The slab was designed to carry a live-load of 150 lbs. per sq. ft., theoretically for a width of 6 in. The center of the steel was approximately 8 in. from the top of the slab. By keeping the steel 1½ to 2 in. from the bottom of the slab, it would necessarily have to be about 10 in. deep and would require a cross-section area of reinforcing steel of about (.4) four-tenths of a sq. in. As we wanted to hold the over-all depth to 8 in., the amount of steel was increased to (.78) seventy-eight hundredths sq. in., as an experiment.

Assumptions:

$f_c = 650$
$f_s = 16{,}000$
$E_c = 2{,}000{,}000$
$n = 15$
Shear 75 lbs. per sq. in.

Because of the small section of slab considered, it was almost impossible to consider it as a T-beam section, so it was considered as three simple beams uniformly loaded.

For a live-load of 150 lbs. per sq. ft., it would throw a uniformly distributed load of 2,500 lbs. on each beam, producing a shearing stress of only 39 lbs. per sq. in., which is permissible, most codes allowing from 40 to 75 lbs. per sq. in.

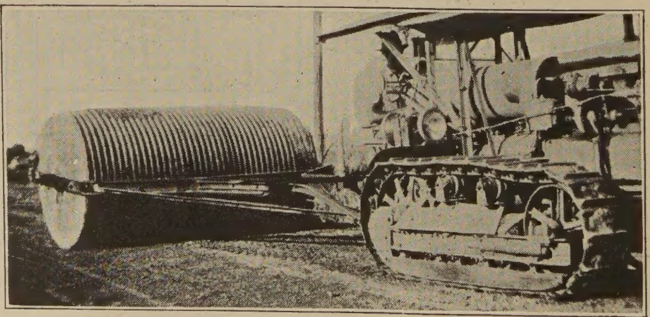
A 1:2:3 mix was used in pouring this slab, ¾-in. gravel being used for coarse aggregate.

Test to Destruction

About 60 days after the erection of the slab, it was decided it would have to be dismantled, hence the reason for testing it to destruction. Two hundred and twenty sacks of cement were placed on the slab as shown in the illustration and it still remained intact. The test was about to be given up on account of rain when 18 of the shop men were added to the load. It still apparently remained intact but later it failed when two cracks appeared as shown on the illustration and sketch. They were painted with black paint in order to show up better in the photograph. At the time of failure we figured the slab was carrying approximately 24,073 lbs. or 481 lbs. per sq. ft., the shearing stress at this time being approximately 191 lbs. per sq. in. At the time of failure we had a deflection of ⅜-in. When the load was removed, the deflection was 3/16-in. Undoubtedly the primary cause of failure was due to the slipping of the steel, the result causing diagonal shear close to the supports.

Concrete Road Roller

The road roller shown is 5 ft. in diameter, 10 ft. long and of solid concrete, having a weight of 14 tons. Its corrugated surface is said to have proven effective.



Code Provisions for Concrete Floors

An Analysis of the Provisions in Several Building Codes

SEVERAL attempts have been made in building codes to give recognition to the greater inertia and the greater fire-resistance of the heavier types of fireproof floors, by permitting designers of such floors to base their computations on a live-load lower than the nominal live-load specified in the code.

One of the first building codes to introduce this principle is the one issued by the Industrial Commission of Wisconsin. Section 5300 of that code permits a flat reduction of 20 lbs. a sq. ft. below the specified live-load if the floor is of fireproof construction. The justification for such reduction is well stated in a footnote, where the following reasons are given:

(1) A fireproof floor suffers little or no deterioration.
(2) A fireproof floor is not weakened by a fire below it.
(3) The greater dead-load of a fireproof floor means that any accidental overload is a small proportion of the combined dead- and live-load.

The "Recommended Building Code," published by the Portland Cement Association, in Section 41, permits a similar reduction of 20 per cent if the floor system is of fireproof construction.

Section 94 of the building code of St. Louis contains a rather complicated method of taking account of the greater dead-weight of fireproof floor construction. This provision is concerned with weight alone, and takes no account of the type of construction; but from the fact that fireproof floor systems ordinarily are heavier to the unit area than floors of combustible construction, the provision affects the fireproof types more especially.

The method employed in the St. Louis code is not entirely satisfactory. In general, where the dead-load and the basic live-load specified in the code are equal to each other, the design load is simply the sum of the two. This is roughly the situation with the lighter types of reinforced concrete floors supporting light floor loads, as in office buildings, hotels and apartment buildings. For illustration, an ordinary reinforced concrete floor of joist and metal dome construction designed to support a live-load of 60 lbs. a sq. ft. is likely to weigh around 60 to 65 lbs. a sq. ft. If the dead-load of the floor is less than the basic live-load, as will be the case with wood joisted construction and to some extent with steel joisted protected construction, the design live-load must be greater than the basic live-load. This, however, also works against reinforced concrete floors in buildings designed for heavy loads such as warehouses, retail store buildings, commercial garages and so on. In these cases the dead-load of the floor is quite sure to be less than the specified live-load, and under the provisions of Section 94 the design live-load must be greater than the basic live-load specified in the code. Where dead-load of the floor is greater than the basic live-load the latter may be reduced, but not many cases fall within this classification.

The Syracuse Code

A new formula now proposed by the building code committee of Syracuse, N. Y., treats this subject in more scientific fashion. While the formula proposed takes account of the weight of the floor rather than its type of construction, the fact remains, as stated before, that the fireproof types in general are heavier than combustible types. The live-load reduction formula proposed by the Syracuse committee is:

$$w = L - \frac{D}{2} + 10, \text{ but not less than } \frac{2}{3} L.$$

In this formula w is the reduced live-load expressed in pounds a square foot, considered as distributed uniformly; L is the basic live-load in pounds a square foot as specified in the building code, also uniformly distributed; and D is the dead-weight of the floor, also expressed in pounds a square foot.

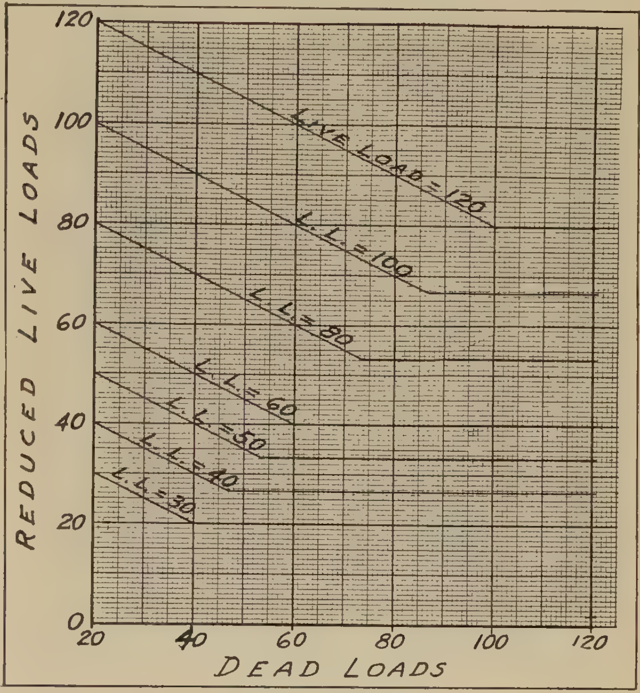


FIGURE 1

A floor with a dead-weight of only 20 lbs. a sq. ft. is not permitted any live-load reduction by this formula. A floor having a dead-weight of 40 lbs. a sq. ft. is permitted a reduction of 10 pounds below the basic live-load. A floor having a dead-weight of 60 lbs. a sq. ft. is permitted a live-load reduction of 20 pounds, while a floor weighing 100 lbs. a sq. ft. is permitted a reduction of 40 pounds in the live-load. In all these cases, however, the reduced live-load may be not less than two-thirds of the specified or basic live-load. This limitation is provided to prevent live-loads from being reduced almost to the vanishing point under certain conditions.

Reduced Live-Load Chart

The reduced live-load for any given dead-load is shown in the diagram designated as Figure 1, from which the reduced design live-load corresponding to any given dead-load may be read directly. The diagram is limited in scope for the reason that the general formula is very simple and may quickly be applied to any case outside the limits plotted. The horizontal parts of the curves represent the limit of two-thirds of the basic live-load.

The purpose of the above formula and the recognition it gives to the heavier dead-weight of certain types of floor will soon become evident from a consideration of certain facts. For instance, a floor of wood joisted construction supporting ordinary loads weighs around 20 to 25 lbs. a sq. ft. The formula would permit little or no reduction in the live-load in that case.

Floors of so-called metal lumber or steel joisted construction are likely to have a dead-weight somewhere between 45 and 50 lbs. a sq. ft., so that for a basic live-load of 60 lbs. a sq. ft. the reduced live-load for this type of floor would be about 45 pounds.

A floor of reinforced concrete and metal dome construction is likely to weigh about 65 lbs. a sq. ft. In that case if the basic live-load is 60 lbs. a sq. ft. the reduced live-load would be 37½ pounds were it not for the limit to two-thirds of the basic live-load, which brings the limit of reduction to 40 lbs. a sq. ft.

In a building of the warehouse type or mercantile classification, a reinforced concrete floor system would be likely to weigh about 110 lbs. a sq. ft. Assuming that the basic live-load for the building is 150 lbs. a sq. ft., the reduced live-load would amount to 105 lbs. a sq. ft.

It is certain that this formula provides a more scientific recognition of the value of a heavy floor than is provided, for instance, by Section 94 of the St. Louis building code. In the illustration just given in the preceding paragraph the St. Louis code actually would require the floor to be designed for a live-load of 174 lbs. a sq. ft., an increase of 24 pounds over the basic live-load of 150 pounds, while the Syracuse formula calls for a design live-load of only 105 pounds.

If for no other reason, the Syracuse formula is worthy of adoption because of the encouragement it gives to fire-resistive floor construction. In a general way it may be said that with fireproof floors of similar type the duration of resistance to fire increases with the weight. The formula gives recognition to this fact.

Record Book Designed to Increase "Repeats"

Products manufacturers who would like to see more repeat orders come their way will be interested in a special record book designed for the purpose of containing all worth while information relative to sales.

The fact that a new customer has been furnished a certain number of block may suggest that a succeeding order will soon be in time. Where is this second order going to be placed? A competing manufacturer may step in, point out the good features of his product, and thus wean away future orders.

Names and addresses are recorded in the book, together with all such data that in any way suggests possible future use. How many brick, and what kind, were delivered? When? Had the customer anything to say? Negative? Positive? Suggestions from the customer may call for desirable improvements, and in that way help the manufacturer to sell greater satisfaction. And particularly when the customer commends the product is there promising reason for future sales.

The special record book enables the concrete block manufacturer to retain all valuable information relating to his business in a compact form. There is the matter of price, when the bill was paid; remarks may be jotted down as to the number of bills and inquiries that were necessary to bring about collection. The manufacturer quickly can find out what customers might be followed up and who should be followed up.

Previous sales naturally suggest likely future orders. For that reason the nature of the first order is carefully recorded, for instant access. When the concrete block buyer hints that he probably will be in the market again, an effort is made to secure a definite date; then this information is put down in the special record book. Someone with an interest for this work in the office should look over the book periodically. From time to time the block buyer is reminded about the good merits of the product, by personal letter, telephone, other sales literature, and personal call. The special record book enables the block manufacturer to keep a figurative finger on all important information pertaining to a given customer or an order, and it enables the sales force to suggest sales when the outlook is timely and most promising.

The special record book eliminates detail, worry, and saves time. When, at the time of a first order, an endeavor is made to obtain relevant information, the customer is favorably impressed; he reasons that the manufacturer is not out only for a single sale. He will naturally co-operate with the manufacturer, and by thus getting into his good graces he can be induced to furnish names and addresses of friends and others who may be interested in blocks, and such other information that will help to bring about orders from them. The names, addresses and other pertinent information might even be kept in a separate book, for individual attention. This second book would show the way to likely sales that otherwise would never be made.

When a customer has been furnished an initial order an attempt, of course, should be made to find out how the blocks satisfied. The customer may come back. But, if he doesn't? What this customer has in his mind may help the manufacturer to make big improvements in his product, and tend to make him a more pleased one. Reasons why customers are pleased should serve as good advertising material. The satisfied customers may, and again may not, come back. They, together with others, should be kept in touch with; interest should be maintained, so that all possible sales will result.

Concrete Tanks for Los Angeles Fish Farm

The accompanying illustration shows concrete tanks used for fish culture in Los Angeles. Each measures 11 by 6½ ft. and is 24 inches deep.

The floor is solid with a pipe so placed that the intake at one end may drip continuously and the flow pass out three inches above the floor at the opposite end. Two low walls that run across the floor are soil and plant containers.

~~ EDITORIAL ~~

Saving Through Quality Control

QUALITY control of concrete is no longer a novelty on concrete construction jobs. Usually the specifications on such jobs make some special provisions encouraging the use of control methods. These provisions enable the contractor to effect economies directly as a result of the new specifications based on quality control methods.

Many contractors say that under such provisions they can see the value of control but under the old 1:2:4 specifications they are forced to work with, they can see no opportunity for possible savings through quality control.

Yet such opportunities ***do*** exist and ***are*** taken advantage of. An illustration of such a job is found in the lead story in this issue describing the construction of a seven-story warehouse in New York City. Here were all the restrictions a contractor is called upon to face. It was a rush job, winter construction, and a 1:2:4 specification regardless of the strength that might be obtained from such proportions.

What advantage would the newer methods of manufacturing concrete result in under these conditions? Several—and they were of importance. By making a concrete of high early strength, winter construction could proceed at a more rapid pace; there was greater assurance that the job would be ready for occupancy at the specified time; and considerable economy could be effected in form costs. As a matter of fact, the contractors were able to remove their forms in four days so that only one set was required for the job—a direct result of quality control. A saving of $3,000 was effected by cutting the time required to complete the job.

Then, by utilizing their knowledge regarding increased yield from properly proportioned aggregates, the contractors were able to make another saving of nearly $2,300 on this item alone.

The cost of those control items that would not occur under the old methods of placing concrete was estimated at slightly under $2,000, leaving a clear saving of $3300 when only the two savings mentioned above are considered.

Can there be any doubt that quality control is worth while on ***any*** job when these facts are considered?

Though quality control is being used on steadily increasing numbers of jobs, there is still a vast amount of concrete placed under the old hit-or-miss methods. It is thought that in order to make the newer methods practical and worth while from the contractor's point of view, the concrete must be placed under specifications especially written for that purpose. Such specifications, it is true, are to be desired but the jobs they cover are not the only ones on which there is a distinct economy in control methods.

◆

Cement Standards

WHILE this issue is going to press, the report of Committee C-1 of the American Society for Testing Materials is being presented at Atlantic City. There is much of interest to the concretor in this report, especially in the light of his experiences in the purchase of cement.

No changes in the present standard specifications for portland cement are suggested, the committee's report concerning itself chiefly with studies of the present methods of testing cements. It is here that some interesting facts are brought out.

Sub-committee VII on strength presented a lengthy report tabulating the results of tests made by 47 laboratories on 32 portland cements. An outstanding feature of this report is the wide variation between the results from the different laboratories from the same cements. Most of the laboratories passed all of the cements while some of them rejected many of them. In the strength tests, also, there was a great variation in the results.

This report, based upon tests of more than 63,000 strength specimens, involved a tremendous amount of work. It showed conclusively that there was a definite need for more uniformity in carrying out the prescribed tests and the recommendation of the advisory committee to establish a special laboratory where testing equipment can be calibrated and where directions for making uniform tests can be compiled for distribution will do much to reduce the variation in results. Until that is done, the question of whether or not a cement meets the standard specifications depends to some extent upon which laboratory makes the tests.

Such a program is particularly necessary now when so many claims are made for certain brands of cement. It is difficult to establish from laboratory tests whether one brand of cement will yield higher strengths at various ages than another when tests on the same brands in different laboratories show such a wide variation in strengths.

P. G. RILEY
President

P. G. RILEY
GENERAL CONTRACTOR

~~701 Temple Street, Pittstown, N. J.~~

Los Angeles

T. G. McGOVERN
General Supt.

Dear Mac:

I am getting a big kick out of my visits with a great old character, a night-watch on a good sized job here. Sure, I know I should be at home nights, but Mother stays overnight once in a while with a friend of hers, so that turns me loose to be as wild as I want to be.

Old Jim, the night-watch, has been on construction jobs since Solomon built the Temple and is as full of yarns as a dog is of fleas. All I have to do is to furnish the chewing tobacco and prod him along a little and I get an earful of what's wrong with everything.

Last night, about quitting time for the day shift, comes from the yard an old bozo of a mixer, so old that like Job's turkey it had to lean up against the fence to gobble. I saw it and later casually mentioned the fact to old Jim and sure enough, got a rise out of him. He spit about five cents' worth of tobacco juice about twelve feet toward old bozo and was off.

"Listen, old timer," he says, "I can remember back in 1902 when the boss bought his first car, which would go along about ten miles an hour, and it added to his already fair swearing vocabulary, but it was a darn fine machine for 1902.

"About that time, he started using a fountain pen, which I remember smeared his vest with ink and had to be shaken well before using, wasting a lot of time and trying his patience severely, but it was a darned good pen for 1902.

"A while ago, he bought his first radio, which at times shrieked out the wails of the damned in torment, but it was a darned good radio for that time.

"Old timer, does he still ride in that one-lung car of 1902? Not by a damn sight. The one he has now is of 1928 vintage, and he can depend upon it to keep him in touch with six or eight superintendents. He signs his name with a non-leakable pen and in the evenings, with one turn of a knob, he brings to his fireside the music of a band concert in a park in Havana and catches between numbers the clink of ice in tall glasses under the palms. Every one of these comforts has been brought up to date.

"Why in time, will he and hundreds of other contractors place machines, like old bozo there, on the job, to eat up time and cost them money for shut-downs? Answer me that, old timer, answer me that. Old bozo was once a two-bag mixer. Listen, that one-bag mixer on the other side of this job will spit out more concrete than old bozo ever did, without calling for the doctor's assistance either. It's made to handle this 'sticky aggregate' the specifications call for now, which causes bozo to have cramps. It measures water properly which is a guessing contest with bozo, and it discharges this 'sticky aggregate' fast which bozo can't do, not even with a dose of salts. Got another chew?"

That's enough of Jim, but here's where you win, Mac. You hinted you wanted a new mixer for the Johnson School job and I wrote you that your inventory was already too big and to make one of the old machines do. Well, junk the old machine, Mac, and buy a new mixer. You can thank old Jim.

Yours truly,

P.G.

NOTE

P. G. Riley, or P. G. as some of his friends call him, is a hard-headed, close figuring, shrewd and honest contractor who has retired from the active management of his business, leaving Anna Ryan, his faithful and efficient secretary, to manage the office and Tom McGovern, whom he calls "Mac," one of his youngest superintendents, to manage the operating end.

P. G. has gone to California to take it easy and like a fire horse put out to pasture spends some of his time looking longingly toward the city, yearning to get back into the strife.

In his letters to his young friend Mac and occasionally to Anna Ryan he secures a triple advantage. He lets off steam, causes the young people to keep him in touch with the business and is able to give bits of advice gained from his own experience and also gained by getting, as he says, "a bird's-eye view now of the business"—advice that should be of definite use to the young people now carrying on his business and maybe to other contractors who are now given the privilege of reading this one-sided correspondence.

As David Harum said, "There's as much human nature in some folks as there is in others if not more." And possibly P. G.'s human nature which shows in these letters will make them of interest to our readers.

Reinforced Concrete Design Simplified

Chart D-1—Diagonal Tension and Shear

By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

Joint Committee Specifications

$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$n = 15$

$$v = \frac{V}{bjd}$$

$$j = \frac{7}{8}$$

Maximum, $v = 40$ lbs. per sq. in., no web reinforcing.
Maximum, $v = 240$ lbs. per sq. in., with web reinforcing and special anchorage.

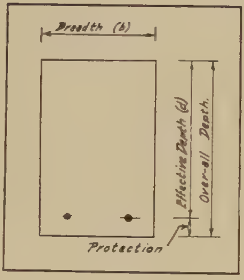


CHART D-1 is designed to determine the unit shear in reinforced concrete beams, solving the equation:

$$v = \frac{V}{bjd}$$

V = Total shear at any section, lbs.
v = Unit shear at same section, lbs. per sq. in.
j = Arm of resisting couple, taken as ($\frac{7}{8}$) for use in this equation.
b = Breadth of beam, inches.
d = Effective depth of beam, inches.

Chart D-1 Application

In the May issue an illustrative problem was solved: *Required:* to design a concrete beam, reinforced for tension, for a simple span of 25 feet with a live-load of 1000 lbs. per lin. ft. The information finally determined, for the limiting values of stress was:

Breadth (b) = 16 in.
Effective depth (d) = 25 in.
Over-all depth = 27 in.
Area of steel = 3.55 sq. in.

The total shear must be obtained before the unit shear can be found. Referring to Chart B, the total dead-load on the beam may be found by an isopleth from the unit dead-load to the span. Likewise, as explained in the May issue, if the unit live-load is used instead of the unit dead-load, an isopleth from that value to the span will give the total live-load on the beam. Thus on Chart B, isopleth (4) gives the total dead-load weight, while isopleth (1) gives the total live-load on the beam:

	Lbs.
Total weight of beam	11,000
Total live-load	25,000
Total combined load	36,000

$$\text{End shear} = \frac{36{,}000}{2} = 18{,}000 \text{ lbs.}$$

Chart D-1, as will be explained later, is composed of two distinct charts with a common scale called the "support." There will be, for any solution, two isopleths intersecting at the support. The scales have been given letters to indicate which ones must be used together. Thus the usual procedure is to draw an isopleth between the two outside scales marked (A), then a second isopleth between the inside scales marked (B) through the intersection of the first isopleth and the support. Thus on Chart D-1 isopleth (1) has been drawn between values of ($b = 16$ in.) and ($d = 25$ in.). Through the intersection of isopleth (1) and the support isopleth (2) has been drawn to a value of the total shear equal to 18,000 lbs., and on the unit shear scale is noted a value of ($v = 51.4$ lbs. per sq. in.).

$$v = \frac{V}{b\frac{7}{8}d} = \frac{18{,}000}{16 \times \frac{7}{8} \times 25} = 51.4 \text{ lbs. per sq. in.}$$

Reinforcement for this web stress will be discussed under later charts.

Web Stresses

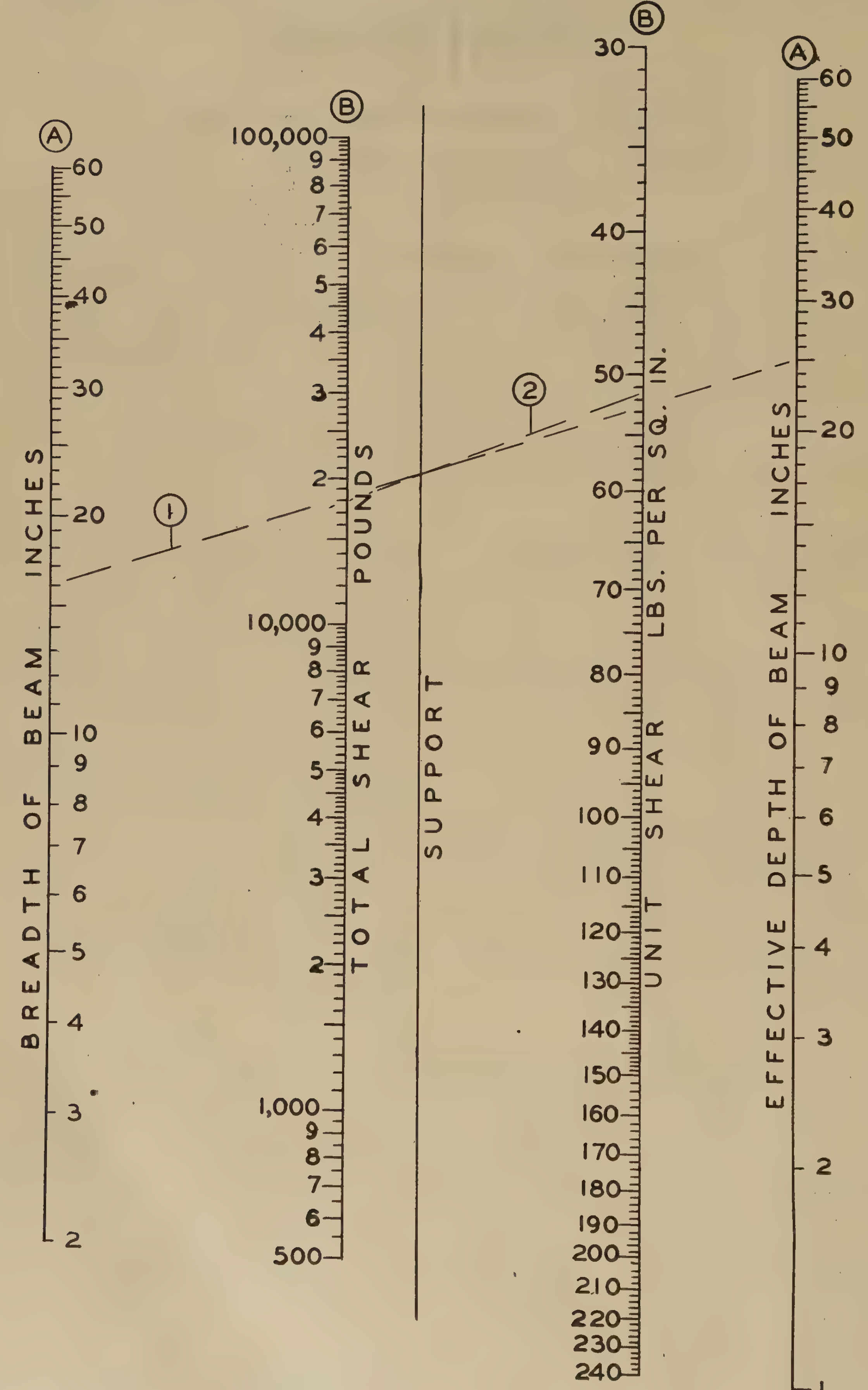
In all of the preceding discussions the stresses considered have been limited to the maximum unit compression in the concrete (f_c) and the unit tension in the steel (f_s). There are, however, other internal stresses existing in all beams that sometimes cause failure if neglected. In the ordinary homogenous beam these internal web stresses are not quite so important, although the writer had occasion to investigate a timber railroad trestle in which the web stresses were causing failure. In reinforced concrete beams the neglect to investigate the web stresses should never be countenanced. They may be small enough to be safely carried by the concrete, but should at least be investigated.

Shear

If a number of boards, one on top of another, are used to support a load, Fig. 1-D-1, there will be a tendency for

CHART D-1

Diagonal Tension and Shear



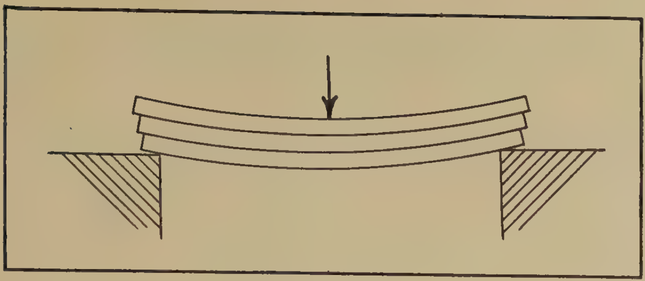


Figure 1-D-1

the boards to slip on each other causing the ends to overlap. If these boards are either nailed or glued together, the tendency to slip will still exist, but is prevented from slipping by the horizontal shearing resistance of the binding material. The intensity of this horizontal shearing stress, which is equal to the vertical shearing stress at the same section, is found by the formula specified by the Joint Committee:

$$v = \frac{V}{bjd} \qquad \text{Eq. 1-D-1}$$

v = Unit shearing stress, lbs. per sq. in.
V = Total shear at sections, lbs.
j = Arm or resisting couple, taken as $\frac{7}{8}$.
b = Breadth of beam, inches.
d = Effective depth of beam, inches.

The limiting values in shear as permitted by the Joint Committee are listed in the March issue under "Summary of Working Stresses." Under these specifications, the maximum shear permitted is:

$$v = 0.12\, f'_c = 0.12 \times 2000 = 240 \text{ lbs. per sq. in.}$$

So Chart D-1 has been drawn to include this limit. There seems to be, however, some difference of opinion as to whether the special anchorage specified by the Joint Committee (see March issue) warrants such high shearing stresses. Conservative designers are therefore limiting themselves to the stresses permitted under the heading of "Longitudinal Bars Without Special Anchorage." This would limit the shearing stress to the value:

$$v = 0.06\, f'_c = 0.06 \times 2000 = 120 \text{ lbs. per sq. in.}$$

This value will be used in this series as the maximum permissible shearing stress.

Adequate web reinforcement will be discussed in a later issue. At present we are only concerned in finding the magnitude of the web stresses. Since the unit shear is a function of the total shear, the beam should first be investigated at the section of maximum total external shear. In case of doubt, the shear diagram should be plotted, which for uniform loads is quite simple.

Continuous Beams with Concentrated Loads

Continuous beams come under the classification of statically indeterminate structures in which the reactions can only be determined by considering the flexure of the beam. Handbooks usually give formulas for determining the reactions of beams continuous over any number of supports for equal spans and uniform loads. Beams of unequal spans with concentrated loads not in the center of the spans represent a real problem for most designers. So a little discussion of a rapid method of approximation of this problem will perhaps be appropriate at this time.

The writer first became interested in the Beggs Mechanical Solution of Statically Indeterminate Structures while designing the catenary structures and signal bridges for the Illinois Central electrification at Chicago. A more thorough understanding of the following discussion can be had after reading the original of Prof. Beggs' discussion in the Proceedings of the American Concrete Institute of February, 1922. The underlying principle of this method is:

> "The influence line for any external reaction is the deflection diagram produced by a unit displacement of the point of application of that reaction."

Being the first commercial user of this method of analysis, the writer naturally turned to it when confronted with the problem of designing reinforced concrete beams continuous over many supports supporting concentrated truck loads. Thinking that many designers are confronted with the same problem, considerable time was spent on devising some method of economically applying the mechanical principle. The Beggs Deformeter Gages are economical for larger structures, but for continuous beams represent too much initial outlay and require too much time for solution. After trying many materials that finally used consisted in a 12-in. length of tempered No. 19 steel wire made as straight as possible, and a half dozen glass-headed push pins. The following problem is given to illustrate the method.

Let us take the case of a two-span beam continuous over the central support, with spans and load as shown in Fig. 2-D-1. Required to determine all reactions. The beam is laid out to some convenient scale, the larger the better, but such that the scaled length is less than the length of the wire. Push-pins are then placed at points (C) and (D), representing reactions R_2 and R_3, such that when the wire is deflected at R_1 the top of the wire will pass through points (C) and (D). A third push-pin is then placed a unit distance below point (A), representing R_1, at point (B). The wire is then deflected about the push-pins as in Fig. 3-D-1. Some practice and considerable caution is necessary in order to get the push-pins so placed that the top of the wire will pass through points (B), (C), and (D). The position of the wire then represents the deflection diagram for a unit displacement of the reaction R_1 and is therefore the influence line for that same reaction. This influence line can be now drawn, using a fine pointed pencil, by tracing along the top edge of the wire. It will be seen, from the definition of an influence line, that the ordinates from the origin to the curve at any point represent the reaction R_1 for a load of unity at that point. Ordinates above the origin will represent negative reactions, while ordinates below will indicate positive, or upward, reactions. Thus for a load of

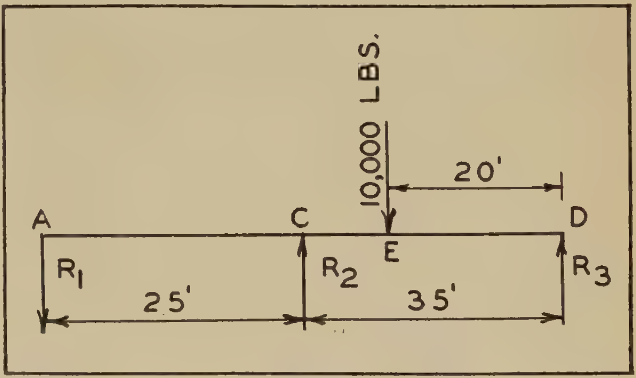


Figure 2-D-1

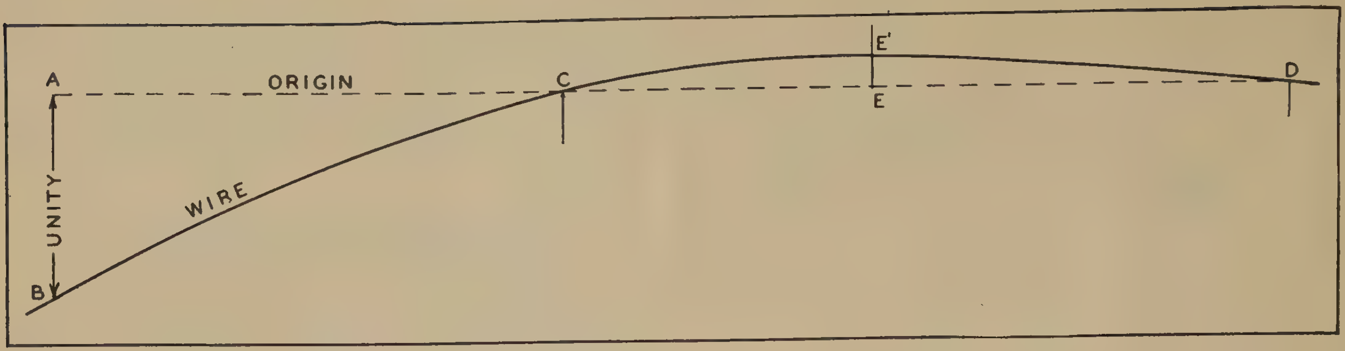


Figure 3-D-1

unity at point (*E*), Fig. 3-D-1, the scaled amount of *E-E'* with the distance *A-B* as unity, is the reaction R_1. Reactions at R_1 for loads of any magnitude at point (*E*) can then be obtained by direct multiplication.

The push-pins are then arranged on the same diagram for a unit displacement of point (*C*) with the wire passing through the three points (*A*), (*F*), and (*D*), Fig. 4-D-1. This gives the influence line for reaction R_2. The influence line for the reaction R_3 can likewise be drawn by making a unit displacement of point (*D*). Fig. 4-D-1 shows the three influence lines with co-ordinates indicated at point (*E*) in order to ascertain the three reactions. Table 1-D-1 gives the comparative results, analytical with mechanical, for the original 10,000-lb. load at point (*E*).

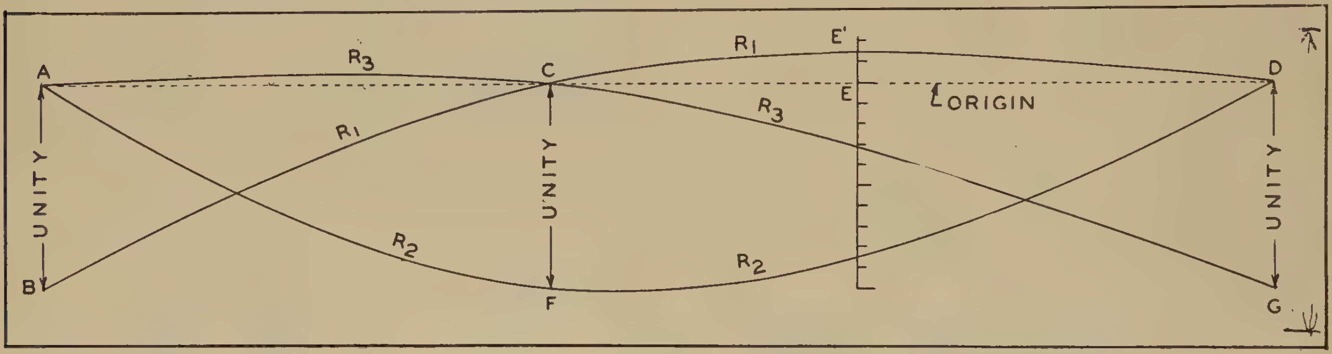


Figure 4-D-1

TABLE 1-D-1

Reactions in Pounds for 10,000-lb. Load at Point E

Point	Influence Line		Analytical
	Ordinate	Reaction	
R_1	—0.15	—1500	—1565
R_2	+0.315	+3150	+3160
R_3	+0.85	+8500	+8440

It will be seen, by the results in Table 1-D-1, that the results are all within the accuracy usually demanded.

Deflections should not be made so large that the wire will be stressed beyond the elastic limit thereby putting a permanent kink in it. After making deflections, the wire should return to its original straight condition. As the wire is of uniform section throughout, it represents a beam of uniform section. If the spans differ by any large amount, the moment of inertia of the various sections will probably vary in an economical design. This change of section can be taken into account in the Beggs method by varying the depths of the model according to the cube root of the moments of inertia. Since it is not possible to change the section of the wire, an inaccuracy will be produced by this method. Even with such errors, the wire will give results much more accurate than the methods of approximation most designers use.

Diagonal Tension

The cracks that develop near the points of support of a reinforced concrete beam, Fig. 5-D-1, are largely due to what is known as diagonal tension. Diagonal tension is due to the combined action of shear and horizontal tensile stress. As stated in the April issue, the tensile resistance of the concrete is neglected. The magnitude of the diagonal tension in a reinforced concrete beam then becomes very difficult to accurately determine. Tests have shown, however, that the unit shear as computed by Eq. 1-D-1 may be accepted as a convenient measure of the diagonal tension. The use of shear as a measure of diagonal tension has been almost universal and is so considered by the Joint Committee.

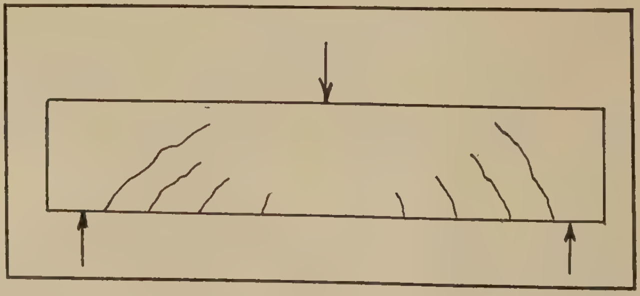


Figure 5-D-1

Construction of Chart D-1

The formula for determining the unit shear in a reinforced concrete beam

$$v = \frac{V}{bjd} \qquad \text{Eq. 1-D-1}$$

is in reality a five variable expression. The variations of (*j*) are so slight, however, that it is usually taken as

$(j = 7/8)$ when determining the unit shear. Thus the equation reduces to the form of a four variable:

$$v = \frac{V}{b\,7/8\,d}$$

Since the nomograph is based on a three variable equation, the above expression may be transposed to the form

$$bd = \frac{V}{.875\,v}$$

Each side of this last expression can now be equated to the same variable (y):

$$y = bd$$

$$y = \frac{V}{.875\,v}$$

If the nomograph for each of these equations is placed on the same sheet with scales so arranged that one scale for (y) can be utilized for both, isopleths for any set of conditions will intersect on the (y) scale. When, as in this case, the common variable (y) is of no concern as to magnitude, its scale is not calibrated. A line is drawn at the proper location and called the "support," or by some authorities, the "working line."

The first expression we have to deal with is

$$y = bd$$

The nomograph will have (y) as a central scale and values of (b) and (d) will appear on the two outside scales (L) and (R) respectively. Since (b) and (d) will have approximately the same range of values, we will assume equal logarithmic co-ordinates for their scales making

$$r = 1$$

Equating the general exponents of Eq. 7, $C = L^{mn/r} \cdot R^{m(1-n)}$, to the actual exponents of the expression $(y = bd)$, we have the two expressions

$$\left.\begin{aligned} \frac{mn}{r} = \frac{mn}{1} &= 1 \\ m(1-n) &= 1 \end{aligned}\right\}$$

When these two expressions are solved simultaneously, we get the values

$$\left.\begin{aligned} m &= \frac{1}{2} \\ n &= 2 \end{aligned}\right\}$$

Thus the (y) scale, or support, must be half way between the (b) and (d) scales and have logarithmic co-ordinates one-half the size of those used for the (d) scale. The $(A\text{-}10)$ scale was used for values of (b) and (d), necessitating thereby the use of the $(A\text{-}5)$ scale for values of (y) if plotted.

The second expression to be considered is

$$y = \frac{V}{.875\,v}$$

which can be written in the form

$$y = \frac{V\dfrac{1}{v}}{.875}$$

As usual, the constant (.875) will only have the effect of shifting the scales up or down. The variable $(1/v)$, being the reciprocal of (v), will have an inverted scale increasing in magnitude down the page.

The co-ordinates for the (y) scale are fixed. Since the range of values for the total shear (V) will be much more than for the unit shear (v), the $(K\text{-}10)$ scale will be assumed for values of (V) and the $(D\text{-}10)$ scale for values of (v). The $(A\text{-}5)$ scale used for values of (y) has co-ordinates one-fourth the size of the $(D\text{-}10)$ scale used for values of (v) making

$$m = 4$$

The $(K\text{-}10)$ scale used for values of (V) has co-ordinates one-third the size of the $(D\text{-}10)$ scale used for values of (v) thereby making

$$r = 3$$

Equating the general exponents of Eq. 7 to the actual exponents of the expression $y = \dfrac{V\dfrac{1}{v}}{.875}$ we get

$$\left.\begin{aligned} \frac{mn}{r} &= 1 \\ m(1-n) &= 1 \end{aligned}\right\}$$

Substituting the values of $(m = 4)$ and $(r = 3)$ in the first of the above equations we get

$$\left.\begin{aligned} \frac{mn}{r} &= 1 \\ \frac{4n}{3} &= 1 \\ n &= 3/4 \end{aligned}\right\}$$

This value $(n = 3/4)$ indicates that the two outside scales must be so located that the (y) scale, or support, will be three-fourths the distance between the (v) and (V) scales. The three scales, b, d, and v, are laid out so as to give the desired range of values. An isopleth was then drawn through the values $(b = 10)$ and $(d = 10)$. Through the intersection of this isopleth with the support a second isopleth was drawn through the value $(v = 100)$. The second isopleth intersects the (V) scale at a value of

$$V = .875vbd = .875 \times 100 \times 10 \times 10 = 8750 \text{ lbs.}$$

This point then gives the necessary information for starting the (V) scale. Fig. 6-D-1 gives the details by which the original of Chart D-1 was laid out. In order to save confusion the scales were lettered by pairs (A) and (B). Isopleths must be drawn between scales of like letter.

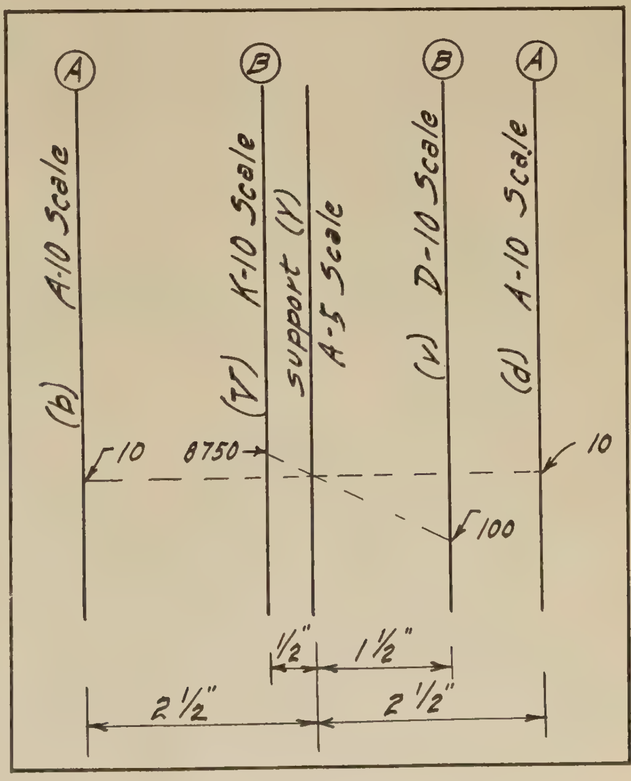


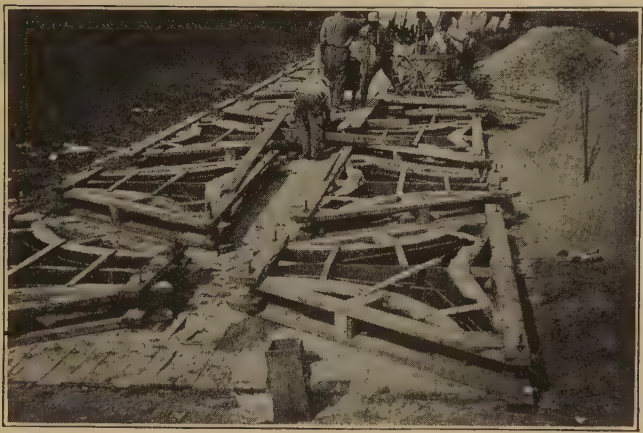
Figure 6-D-1

Precast Penstock Saddles

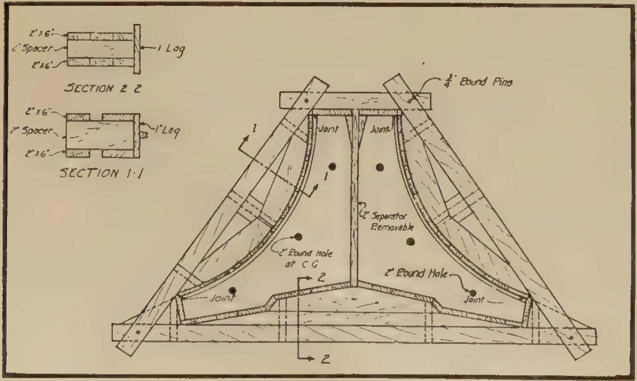
Form Details and Methods Used in Casting Penstock Saddles for a Vermont Power Development

By C. W. MAYERS
Chief Engineer, Morton C. Tuttle Co., Boston

THE Canaan (Vermont) development of the Southern New Hampshire Hydro-Electric Corporation, recently completed by the Morton C. Tuttle Company, engineers and builders, of Boston, included about 1400 feet of 9 feet 6 inches diameter wood stave penstock.


The casting platform. Three-quarters of a yard of concrete was required for each saddle

One of the most interesting parts of the work was the building of the two-piece precast concrete saddles which supported this penstock. A form was designed, as shown in the accompanying sketch, in which two half saddles were cast back to back at the same time. A pin at each lower corner of the form acted as a hinge, while the pins at the two upper corners held the top section of the form in place and acted as locks. The 2-inch strip separating the two halves was removable. A groove was required in each saddle to take the penstock hoop and this groove was formed by a beveled strip of wood bent into place. The holes were formed with short pieces of old boiler tube. Twenty of these forms were built.



Working drawing of the forms used

A casting platform 16 feet wide and 120 feet long was constructed of 1-inch boards supported by 4 by 4 stringers 3 feet on centers. Three-quarters of a yard of 1:2:4 concrete was required for each saddle. This was mixed in a small gasoline driven mixer, and delivered to the forms by means of buggies. Forms were thoroughly oiled before concrete was placed. The reinforcement was laid in place as the concrete was poured. Concrete was allowed to set 48 hours before forms were stripped and then left in place four to five days before being removed from the platform. Stripping was accomplished by simply removing the top pins and swinging the sides of the form outward.

Form Removal

Some difficulty was experienced at the start by the groove strip sticking when the forms were removed. This was remedied by tacking a strip of oiled paper along the face of the strip. It is suggested that for a form of this type a metal strip might be more satisfactory. After stripping, the forms were piled two deep along the side of the platform, located so as to allow easy access to the completed saddles for handling. After an average use of 7½ times (sufficient to make 150 saddles) the forms were still in good condition.

The penstock saddles in place

The method of handling the completed saddles was very interesting, though simple. Each half saddle, weighing about 1600 pounds, was lifted with crowbars into an upright position. A contractor's cart with an arched rear axle was backed over the casting, which was lifted by means of a chain and pin through the middle hole. In this way the castings were moved to a storage pile at the end of the casting platform, and later to the penstock line where they were set in place. While in storage they were frequently sprinkled.

The labor cost of forming and casting was approximately $8.00 per saddle, this cost being almost equally divided between forms and concrete.

Pipe Plant Layout in the Fertile Florida Field

Large Production from Well Designed McCracken Plant at Miami, Fla.—Materials Proportioned on Belt Conveyor —Plant Layout—Tests of Pipe Produced

IN Florida 30,000 linear feet of concrete sewer and culvert pipe are made every day and a good share of this production is the output of the McCracken Pipe Company's plant at Miami.

This is the third manufacturing unit established by W. J. McCracken and his associates in Florida, the two other plants being at Tampa and Sanford. The Miami company was organized January 1, 1927, and proceeded to the erection and equipment of a modern factory for the economical production of pipe. E. H. Backemeyer is secretary and general manager of the Miami plant.

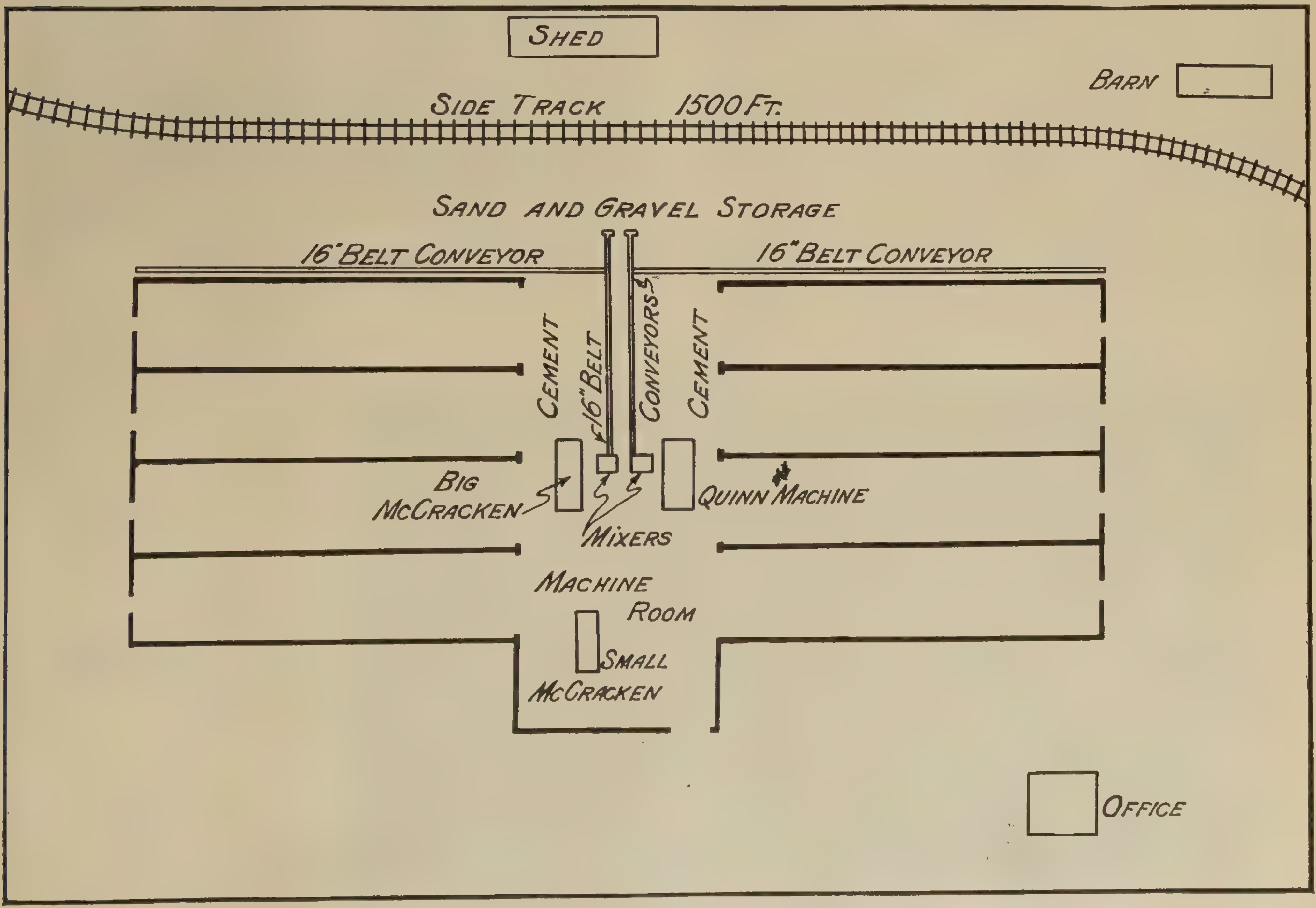
Even with the comparatively cheap labor available in the South, no detail has been overlooked in the plant equipment to substitute machine operation for man power. The production units are a McCracken machine for making pipe 6 in. to 24 in. in diameter and a Quinn machine for sizes 27 in. to 60 in.

Aggregate Handling

Raw materials are shipped in by railway, clean gravel coming from Flomaton, Ala., and Chattahotchee, Fla., and sharp sand from Lakewater, Fla. Freight cars are unloaded by crane to storage piles. Cement cars are spotted at the door of the plant nearest the mixers and are unloaded by laborers, cement (always in paper) being stored in the plant handy to mixers.

A conveyor belt runs alongside the plant, between the buildings and the sand and gravel storage. Laborers at the material piles prepare batches of sand and gravel in respective batch boxes arranged over the conveyor. Upon a bell signal from the mixer operator inside, the boxes are discharged onto the belt which carries the batch to the door of the plant and discharges onto another belt running at right angles to the first. The second belt discharges directly into the 21-ft. mixer and the proper amount of cement is added to the batch by the mixer operator. The batch is given a two-minute dry mix before water is admitted from an accurately gauged water measuring tank.

The conveyor operations are accurately timed, one conveyor system serving each of the two mixers and each



The plant layout

A conveyor belt carries the proportioned aggregate batches to the mixer

mixer serving one of the production machines. Each raw material batch reaches the mixer in time to eliminate waiting but never gets there until the mixer has discharged the previous batch into the elevator boot of the pipe machine. Proportions vary according to the kind of unit being made but generally run 1 cement, 1.5 sand and 1 gravel, with sufficient water to produce a workable, plastic mix.

Curing

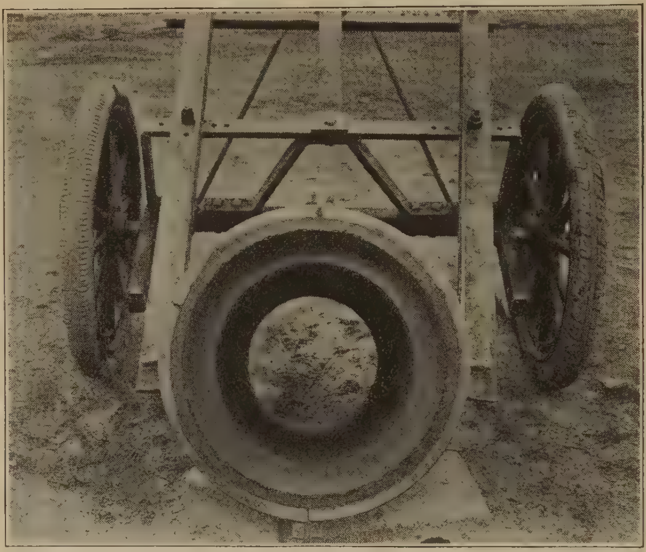
As the pipe come from the machine they are wheeled, still in their molds, into the kilns, of which there are eight, 30 by 125 ft., with level concrete floors. The pipe are transferred without pallets. They are cast on the machine bell end down but are swung over on the cart and deposited on the curing room floor bell end up. The molds are released at once and returned to the machine as the green pipe are so densely packed as to be able to stand unsupported 30 seconds after they are made.

Ample storage facilities are afforded by 11 acres of ground. No truck deliveries are made, contractors in every case coming after the pipe they need. The plant has a shipping radius of about 200 miles.

Concrete pipe are popular in Florida, about 1,563,000 feet of McCracken pipe being laid in 1926 and a somewhat smaller amount in 1927 due to the curtailment of construction work. The city of Miami has laid many miles of McCracken pipe, chiefly in sanitary sewers. In all, 54 Florida cities use these pipe for sewers.

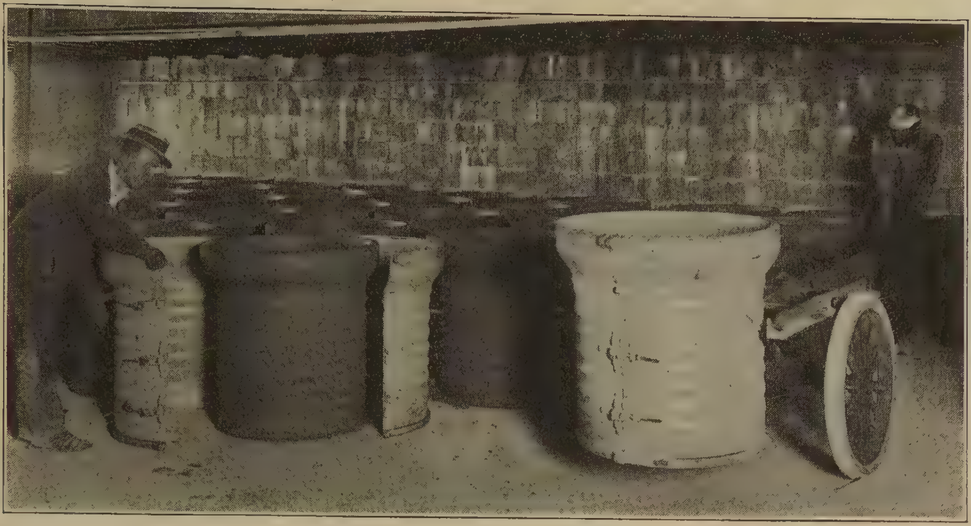
Tests

Engineering standards governing sewer materials are generally very high in Florida, a situation which works to the advantage of manufacturers of worthy products. The tests mentioned here, made by the Pittsburgh Testing Laboratories for the city of Miami, were on pipe only two weeks old. The sewer program was being rushed to completion at such speed that contractors were laying 15-day pipe in the trenches and for that reason unusual care was taken in making the tests.



Showing how the bell end is densely packed and illustrating the method of transporting pipe

An interior view of the plant, showing arrangement of the machinery



The molds are released at once and returned to the machines

McCracken pipe in the curing room

TESTS ON 8-IN. PIPE

Crushing Test (Sand Bearing)

Diameter In.	Length In.	Total Load Lbs.	Load per Lin. Ft. Lbs.	Minimum Required Lbs.
8	36	5760	1920	1900
8	36	6480	2160	1900

Hydrostatic Test

	No. 1	No. 2
5 lbs. water pressure for 5 min.	OK	OK
10 lbs. water pressure for 10 min.	OK	OK
15 lbs. water pressure for 15 min.	OK	OK

Absorption Test

	No. 1	No. 2
Weight, dry	1225 gr.	1503 gr.
Weight after 5 hr. boil	1296 gr.	1601 gr.
Difference	71 gr.	98 gr.
Absorption	5.9%	6.5%

Visual Inspection (On Job)

Total pieces	400
Total rejects	0
Total accepted	400

TESTS ON 10-IN. PIPE

Crushing Test (Sand Bearing)

Diameter In.	Length In.	Total Load Lbs.	Load per Lin. Ft. Lbs.	Average Required Lbs.
10	36	6240	2080	2050
10	36	6240	2080	2050
10	36	6480	2160	2050
10	36	6960	2320	2050

Hydrostatic Test

Nos.	1	2	3	4
5 lbs. water pressure held for 5 min.	OK	OK	OK	OK
10 lbs. water pressure held for 10 min.	OK	OK	OK	OK
15 lbs. water pressure held for 15 min.	OK	OK	OK	OK

Absorption Test

	No. 1	No. 2	No. 3	No. 4
1st weight	586 gr.	950 gr.	939 gr.	931 gr.
2nd weight	625 gr.	997 gr.	1000 gr.	980 gr.
Difference	39 gr.	47 gr.	61 gr.	49 gr.
Absorption	6.7%	5.0%	6.5%	5.3%

Visual Inspection

To be made when pipe hauled on job.

TEST ON 21-IN. PIPE

Crushing Test (Sand Bearing)

Diameter In.	Length In.	Total Load Lbs.	Load per Lin. Ft. Lbs.	Average Required Lbs.
21	36	9840	3280	3120

Hydrostatic Test

5 lbs. water pressure held for 5 min.	OK
10 lbs. water pressure held for 10 min.	OK
15 lbs. water pressure held for 15 min.	OK

Absorption Test

1st weight	1803 gr.
2nd weight	1910 gr.
Difference	107 gr.
Absorption	5.9%

Practical Kinks from the Job

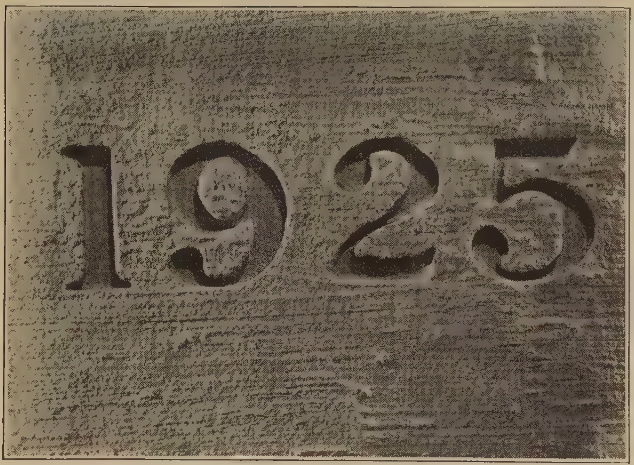
Lettering in Concrete

By R. BAILY CARSON

LETTERS, designs, dates, etc., may be easily cast upon concrete by the following simple procedure: Procure a piece of glassine paper, slightly larger than the design selected. Such paper is frequently used by manufacturers for the outer wrappings of cartons, etc. The letters, date, or design may be drawn directly upon the paper, or the paper may be laid over any printed letters and the design traced upon it with drawing ink.

Now heat a large kettle of water to the boiling point, and drop into it sufficient paraffin, so that when melted, it will form a sheet about ⅛-inch thick upon the surface of the water when it cools. The secret here is to have a considerable volume of water and to place it upon a solid footing free from drafts or vibration while it is cooling. It should cool very slowly. The amount of paraffin to use to secure the required thickness can only be determined by trial and error.

When the water is quite cold, remove the paraffin sheet carefully, place it upon a clean flat surface and lay the glassine paper upon it with the side containing the design uppermost. Heat a small wire and touch the parts of the design lightly in a number of places, to tack each letter or figure to the paper, and when securely attached, turn it over and place it upon a sheet of white cardboard. Now remove it to a warm place, so that the paraffin may be cut easily and will not be so cold as to be brittle. With a small knife, chisel or other tool, cut away the paraffin, making a neat outline with vertical sides around each letter. This is not difficult, as the paraffin is attached to the paper only upon the letters, where it was touched with the hot wire.

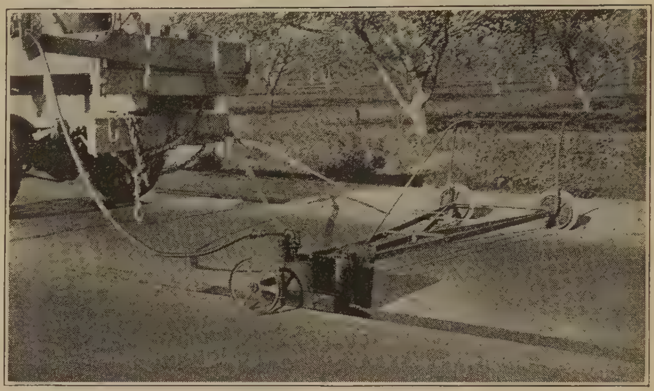


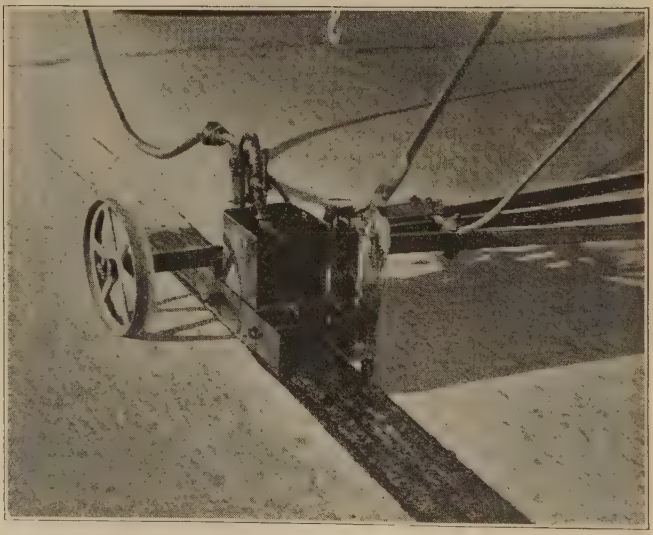
When the letters are cut out, carefully glue the paper containing them to the inside of the form, in which you will cast the concrete. Sift some fine washed sand through window screening, mix two parts of this sand with one part cement and substitute this for the regular mixture used in filling the form, where it comes in contact with the letters. Use special care to pack this fine cement mortar closely about the design so that no air bells will be included.

When the concrete has hardened, it is only necessary to warm the letters slightly to remove the paraffin. Frequently it is possible to pour boiling water over the letters and melt them out.

A Traffic Line Marker Used on California Highways

IN this traffic line marker used by the California Highway Department, three steel wheels are attached to a light framework of structural steel bars and braced at essential points. Thirteen-inch discs are bolted to two of the wheels to act as a flange or guide along the pavement edge. At this end a length of pipe extending upward is used for holding the flange against the edge of the pavement so as to insure a uniformly straight line. At a proper distance from the inside of the flanges is a spray box and fitting loosely over the bottom of the box is a spray box runner. This runner slides up and down freely, so that in its vertical position the runner is independent of the spray box, but its horizontal position is fixed. The runners are always resting on the pavement exactly below the spray box. This prevents the asphalt from spraying beyond the limits of the runner.





An oil heater is mounted on the truck towing the marker and the asphalt oil is fed through a flexible hose into the center spray box. The marker is so light in construction that one man can lift it into a truck for moving from one location to another.

The Study of Concrete Pavement from Core Drill Records

Type and Cost of Equipment Used—Core Drill Reports—Slab Thickness Specifications—Value of Core Drill Record to the Contractor—Adequate Inspection Needed—Cores Reveal Conditions Such as Segregation, Thickness of Mortar Coat, Voids, Etc.—Crushing Strength of Cores—Improvements in Construction Methods Resulting from Study of Core Drill Records

By C. E. FOSTER
Construction Engineer, Michigan State Highway Department

THERE is no subject of more interest to the highway engineer today than the manufacture of concrete. Engineers from all branches of the profession are more fully awake than ever to the necessity of producing the very best concrete possible with the materials at hand. In this state during the past year aproximately 70 per cent of all the roads built on trunk line and federal aid routes had this material as the principal constituent of the metal.

The subject, "The Study of Concrete Pavement from Core Drill Records," is limited in scope, having to do principally with the quality of the work performed. The information secured from the study of specimens taken from concrete roads will be materially beneficial, if future performance of concrete pavement under traffic can be improved by the study of these records.

The state highway department began to core drill pavements in 1922, the object being to determine whether or not proper thickness of slab was being secured. Since that time, one and sometimes two core drill outfits have been operated during the greater part of each construction season.

The equipment itself consists of a shot drill mounted on a truck. The principal items of the drilling outfit are a gasoline engine which operates a vertical shaft through a clutch mechanism to which is attached a cutting head. The cutting head is equipped with a hollow cylindrical cutting bit which, when rotated on the pavement with chilled steel shot as an abrasive, cuts out a core 4¼ in. in diameter for the full depth of the pavement. It takes from one-half to one hour to take a core from the road, depending upon the age of the specimen and the quality of the concrete. The cost of the operation is approximately $35.00 per day, including the rental of truck and drill; supplies, such as gasoline, oil, shot, et cetera; and the salary and expenses of the operator and helper.

Core Drill Reports

The organization and routine reports are very simple. The operations of the core drill equipment are regulated from the central office at Lansing. At the beginning of the season an itinerary is laid out for the outfit, so that the various jobs may be core-drilled with a minimum amount of travel between jobs and as soon after the actual placing of the pavement as is practicable. It is important that the cores be drilled soon after the placing of the pavement, since final estimates on paving projects are not paid until the thickness of the pavement has been determined by core drilling. The operator sends a daily report to the central office on which is shown the number of cores drilled, their locations, their condition and their depths. With these reports at hand it is a simple matter to tabulate the data and show just how the job has been handled. This data is especially valuable when it is possible to core drill completed portions of projects on which paving is still in progress, because there is then an opportunity, in case of variation in the thickness, to see that the new work is placed properly.

As previously stated, the original object in core drilling was to determine the thickness of the pavement placed. In 1922 it was more of an object for a dishonest contractor to skimp on thickness of slab than it is at the present time, because at that time the contractors furnished the cement, which is the most expensive single ingredient going into the manufacture of concrete and which it was a supposed virtue by some to save, if possible. Since that time, however, the state has adopted the policy of purchasing and furnishing the cement—thus the incentive, on the part of a contractor, to save this material has been eliminated. However, there are very few highway contractors who are actually dishonest, that is, those who deliberately try to skin a job. There has been a decided improvement in the road building industry along this line brought about during the past few years by a change in attitude on the part of both contractors and engineers—the former adopting better business practice in their work and the latter improving their specifications so that the work to be done is more clearly defined. But engineers still have to contend with carelessness and lack of knowledge of what is required on even the best managed jobs.

When core drilling was first attempted it was intended to eliminate thin pavement from our construction work. The results have been good, but occasionally a job is found that has gotten out of control, and, in cases of this kind, both contractor and engineer must be dealt with sternly. The specifications which govern thin pavement follow:

Tolerances in Thickness of Pavement

"The pavement shall be constructed strictly in accordance with the dimensions shown on the plans. If proper methods are employed and reasonable care taken, the thickness should not vary more than ½ in. from the thick-

---

A paper read at the Annual Michigan Highway Engineering Conference, University of Michigan, Ann Arbor, Mich.

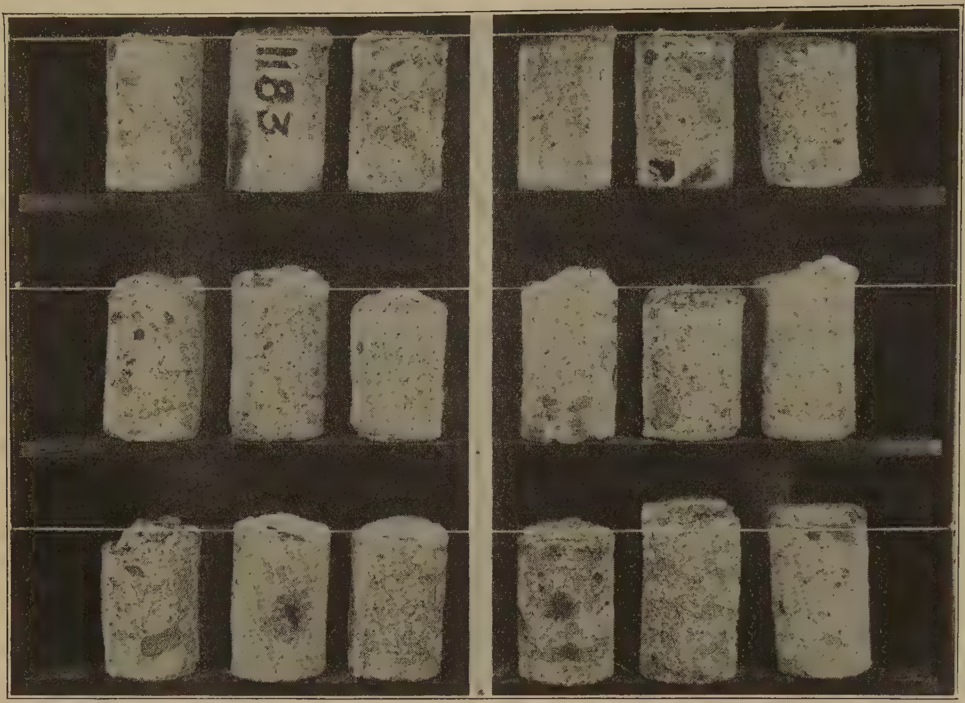


Figure 1. Illustrating careful subgrade preparation

ness shown on the plans. Variations greater than this will be considered due to poor workmanship and the following rules will govern relative to replacing and paying for pavement not built in accordance with the plan dimensions:

"(1) Sections of pavement deficient in thickness more than 1 in. shall be removed and replaced by the contractor, at his expense, with pavement of the specified thickness, and the cost of the cement which was used in the section to be removed will be deducted from estimates to the contractor the same as spoiled cement.

"(2) When the average thickness of the pavement, exclusive of those sections more than 1 in. deficient in thickness, is less than the thickness shown on the plans, the unit price for payment shall bear the same proportion to the contract unit price as the square of the average thickness of the pavement constructed bears to the square of the thickness as shown on the plans.

"The thickness of the pavement will be determined by measuring the length of cores drilled from it. At least one core will be drilled within the limits of each one thousand and fifty-six linear feet of pavement, at such point as the engineer may select. The average thickness will be determined for each mile of pavement, and the fraction of

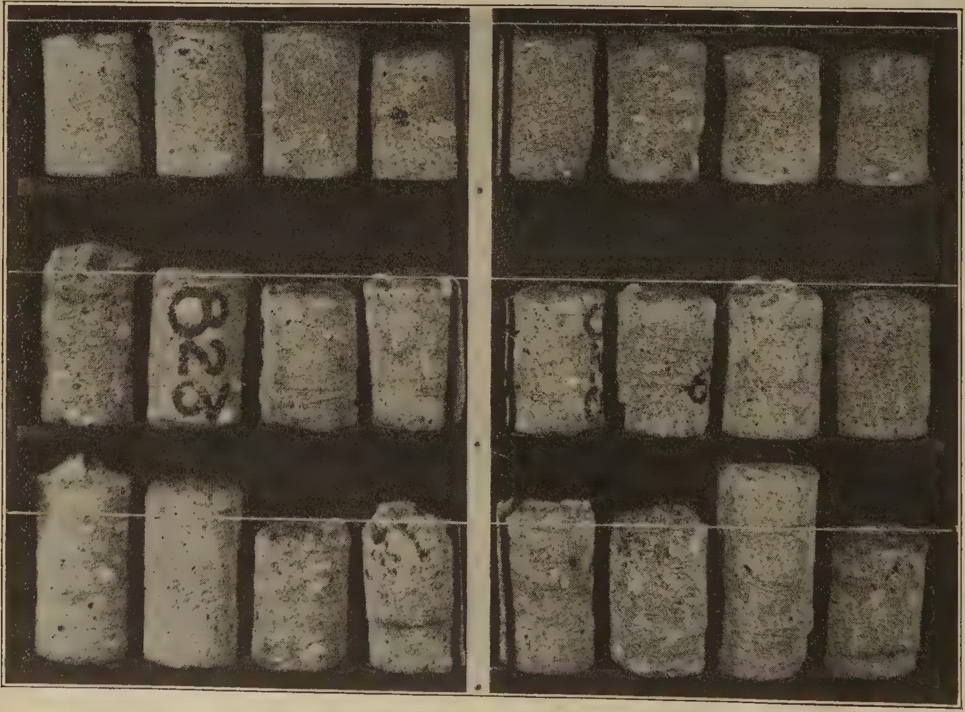


Figure 2. Illustrating poor subgrade preparation

a mile when the contract is of such length that it cannot be divided into an integral number of miles. A unit price for each mile and fraction of a mile will be determined as specified above, and such unit price will be used as the basis of payment.

"The average thickness of the pavement shall be considered as the average of the lengths of the first core drilled from each one thousand and fifty-six foot section, except that no length of core greater than the thickness shown on the plans plus ½ in. and no length of core less than the thickness shown on the plans minus 1 in. will be included in the average."

Value of Core Drill Record to the Contractor

The contractor is furnished with a copy of the core record of his job and aside from the penalty of thin pavement, there is a lesson which he may learn from a study of this record, if he but cares to go into the matter. For instance, suppose the average thickness of the cores is ½-in. in excess of the plan requirements of 7 in. The extra thickness figures slightly over 7 per cent of the thickness required. This percentage translated into extra materials and labor of placing is certainly not less than 5 per cent of the cost of the slab. The cost of this extra thickness is dependent upon the unit cost of the pavement placed, but a figure would be 5 or 6 cents per sq. yd., and amounts to approximately $600 per mile. The extra labor required to make the subgrade perfect should not exceed one-tenth of this sum.

In illustration of the foregoing remarks in regard to subgrade construction, Figure 1 is a photograph of a group of cores taken from a project on which it is evident that very careful subgrade control was maintained. Figure 2 illustrates what may be expected when very little, if any, care is taken in the preparation of the subgrade. The top of the cores in these illustrations is the surface of the pavement and the white line across the bottom of the cores represents plan thickness of pavement.

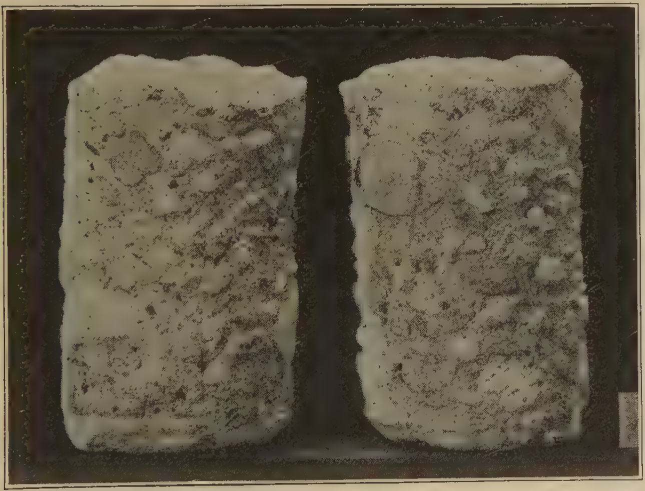


Figure 3. Porous mortar

Concluding the part of this study having to do with pavement thickness, it is obvious from the examples shown that it cannot be taken for granted that a uniform thickness of pavement will be obtained unless adequate and intelligent inspection is provided. When it is found that wide variations in pavement thickness exist, it must be borne in mind that the owner, whether state, county or city, had full power under the specifications to stop the faulty construction as it progressed. If this is not done, and the contractor required to proceed daily in ac-

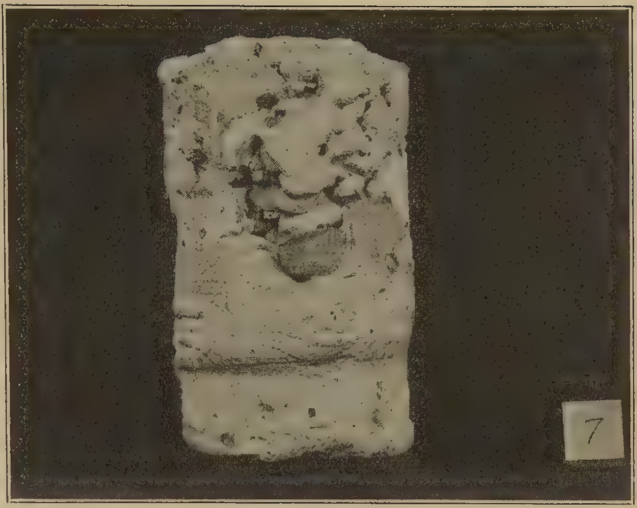


Figure 4. Showing the effect of segregation

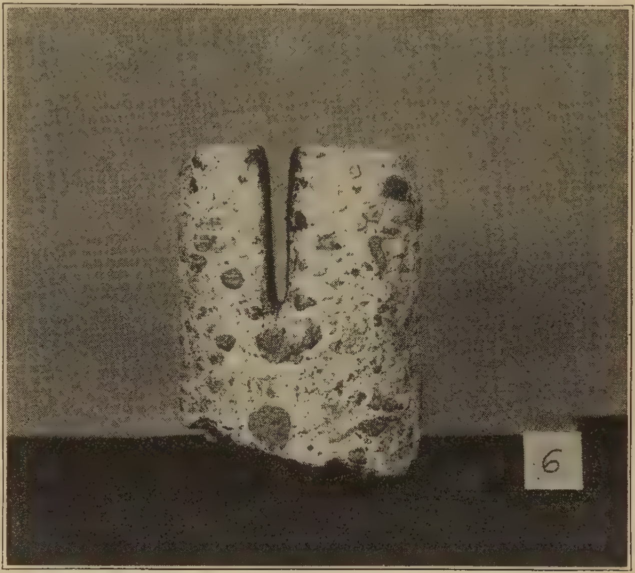


Figure 5. Formed center joint

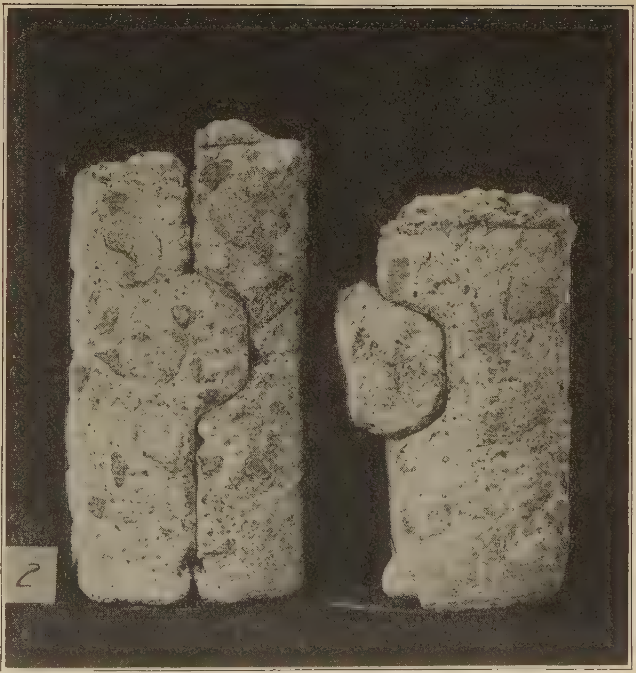


Figure 6. Showing the steel center joint

cordance with the specifications it must be admitted that the result obtained is a measure of the inspection provided.

Aside from pavement thickness there are a number of other interesting features which may be studied from special cores taken from the pavement or from the examination of the regular cores, such as segregation, thickness of mortar coat, air and water voids, etc. Figures 3 to 6 inclusive are cases in point.

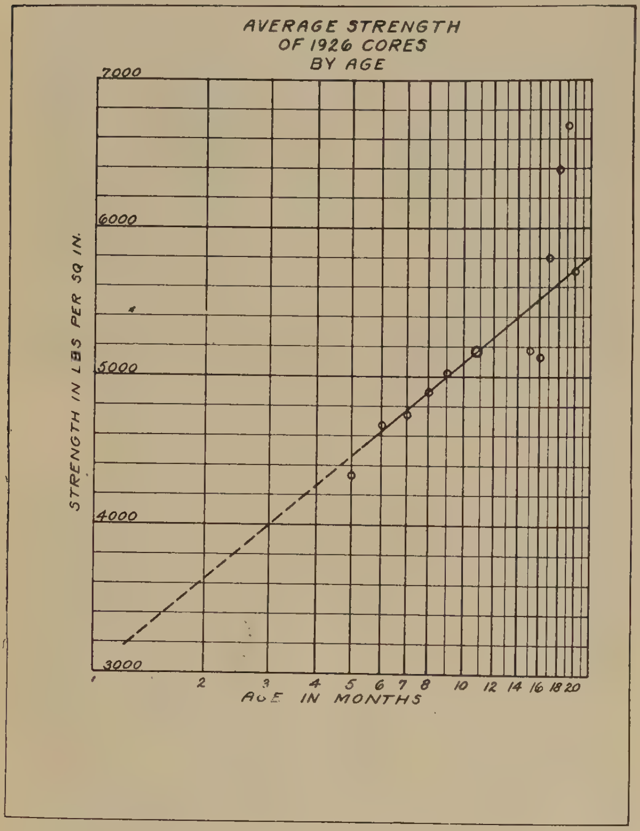


Figure 7

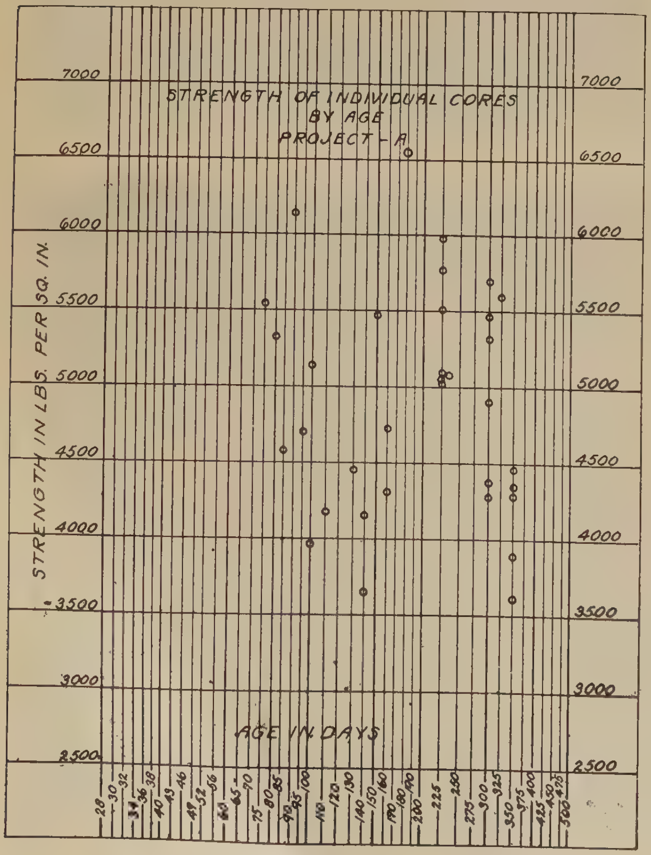


Figure 8

Each year since 1922 a few cores from individual projects had been crushed to determine the strength of the concrete. In 1926 a larger number of specimens were tested and the results arranged in such a way that they could be studied. This work was continued on jobs completed during 1927 and the data for both years follow in the form of a series of graphs of which Figures 7 to 10 inclusive are reproductions.

Figure No. 7 shows the average strength of all of the cores crushed during 1926, strength being plotted as abscissae and age plotted as ordinates. It can be noted that the average strengths fall into a fairly regular curve.

Figure No. 8 shows the strength of individual cores on a typical project. It can be readily noted that there are large variations in strength of the individual specimens.

Figure No. 9 shows the strength of individual cores by age selected from several projects for the purpose of studying the strengths of the individual specimens as well as the average strength in the entire age range. The heavy dotted line connects the average strengths at the various ages. The curve showing the average strengths in 1926 (Figure 7) superimposed on this data indicates a very general conformity to the averages of the previous year. However, the striking thing in connection with this graph is the lack of uniformity of strength between individual specimens.

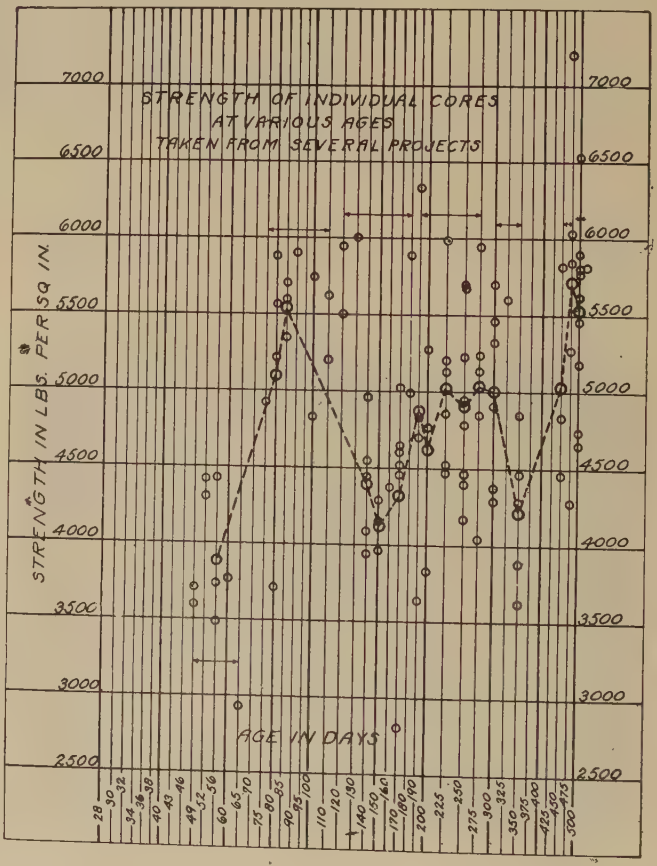


Figure 9

Figure No. 10 is a study of the average strengths of cores of an average age of 205 days on nineteen different projects. The strength range on these projects should be noted.

Strength Test Conclusions

Before any conclusions are drawn the facts should be briefly reviewed. First, it has been shown from the strength charts that there is a decided lack of uniformity in the strength of concrete on the individual projects, the difference in strength of individual specimens of the same age being as much as 2500 lbs. per sq. in. Second, on some projects it has been shown that the average strength of a group of specimens at two or three months of age is stronger than the average strength of another group of specimens much older. This is contrary to the behavior of carefully controlled laboratory concrete, which under ordinary conditions, grows stronger with age. Third, it has been shown that there is a decided lack of uniformity in the average strength of concrete of the same age on a group of projects, the total range of difference in strength on the projects studied being upwards of 2800 lbs. per sq. in. Fourth, visual inspection of the individual cores shows segregation of fine and coarse aggregate, porosity, and other defects.

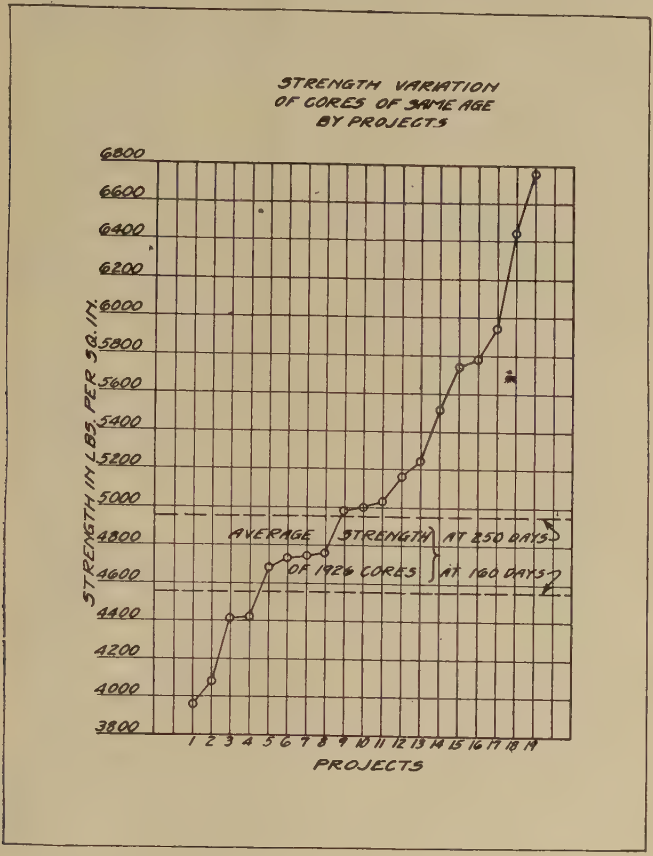


Figure 10

When considering these facts it must be remembered that the specimens tested are actual samples taken from the pavement. The crushing strengths, therefore, represent strength of the pavement—barring improper handling of specimens prior to testing and natural errors in capping the cores and testing them. It should also be borne in mind that all of the materials which went into the construction of the pavements represented by these specimens, passed laboratory inspection and met the requirements of our specifications. The construction methods prescribed by the specifications were followed out as near as it is possible for different engineers to interpret the meaning of the specifications and apply the principles to their work. There is, of course, a human element in the application of these construction methods. But from the observation of many jobs in the field, it would appear that the average interpretation of these methods has been well within the intent of the specifications.

Granting that these facts are true, it must be admitted, that working under the old volumetric specification for proportioning concrete aggregates the strength of the concrete cannot be predicted or controlled unless greater attention is given than heretofore (1) to the segregation of aggregates; (2) to the volumetric changes in the aggregate due to the presence of varying quantities of moisture and (3) to the total quantity of water per batch of concrete.

In other words, to secure uniformity of strength on even a single project it must be possible to easily control the amount of fine aggregate, the amount of coarse aggregate, and the amount of water in each batch of concrete. It is possible to correct for varying conditions in aggregate when using the volumetric method of proportioning, but it is admittedly impracticable, since to secure good results, changes in batch size might be required several times daily with consequent delay in operation of plant. It has been demonstrated that weight measurement of aggregates is practicable and flexible and with this method of measurement, fluctuating conditions of aggregate and moisture cause much less disturbance to the total mineral aggregate in each batch. Adjustments in proportion are also easily possible, involving no more labor than is necessary to change the weights on the scale beam.

Improving Uniformity of Concrete

In view of the results of core strength tests, the Michigan State Highway Department specifications for 1928 paving provide for the proportioning of concrete aggregate by weight and accurate measurement of total water content. For the present, the proportions of cement, fine aggregate, and coarse aggregate will be based upon the characteristics of the materials themselves, in combination, such as to develop the maximum strength with a given cement content per cubic yard of finished concrete. Careful studies are being made of all available aggregates and when these are completed and test results of field concrete made over a period of time, advantage may be taken of the data secured to effect economy by designing for a given strength.

Field research will also be conducted on a number of selected jobs for the purpose of determining just what may be expected in the way of uniformity by accurate field control, taking into consideration all of the factors affecting the strength of concrete. Accurate control of proportioning and other field operations will be established and laboratory practice on the job applied to those operations which lend themselves to laboratory methods.

The study of core records also indicates a need for adequate and high grade engineering personnel, equipped to handle both street and plant inspection—fairly, impartially and, last but not least, daily—so that no regrets may be had after it is too late to correct the conditions which may result in unsatisfactory work.

Cooling Tower

A large reinforced concrete cooling tower is now under construction in England for the Hams Hall generating station of the Birmingham electricity undertaking. The tower is to rise to a height of 220 ft. It will have a diameter of 168 ft. at the base. It is the first of two towers each capable of cooling the circulating water required for a 30,000-k.w. turbine. The cost of the first section of this power station is estimated at £1,500,000 ($7,500,000).

Aerocrete Roofs

By J. GUSTAF V. LANG

Several of the inherent qualities of Aerocrete, a porous concrete previously described in CONCRETE, make this material exceptionally attractive for roofs. In the first place, it is light; secondly, it is fireproof; thirdly, it is heat insulating; and fourthly, it has mechanical strength.

Because of the relative lightness of Aerocrete, roofing slabs of considerable size can be precast with such metal reinforcement as may be required depending upon the distance between the purlins.

In the case of the Aerocrete roof recently laid on a building of the Raritan Copper Works at Perth Amboy, N. J., by the Porete Manufacturing Company—shown in the accompanying illustration—the slabs were 2 ft. wide and 5 ft. long and 2½ in. thick. Such a slab weighs between 115 and 120 lbs. The slabs were reinforced with galvanized wire netting, with longitudinal wires at 1½-in. centers and cross wires at 2-in. centers. The Aerocrete used had a volume weight of 55 lbs. per cu. ft. The aggregate employed in the cement consisted of cinders ground fine enough to pass through a ¼-in. mesh. The proportion of cinders to cement by weight was one to one. The slabs were laid in the same manner as the Porete Manufacturing Company has used for its Porete slabs, utilizing its standard clips for holding the slabs down to the purlins. After the slabs were laid a ¼-in. cement finish was applied.

The Aerocrete concrete roof used on this building for the Raritan Copper Works at Perth Amboy, N. J., weighs only 55 *lbs. per cubic foot*

The lightness of the material naturally makes for reduced cost of steel construction. Should it be found desirable, it is quite possible to surround the steel with a protecting cover of Aerocrete. For this purpose collapsible metal troughs can be used to advantage as molds in which to pour the Aerocrete.

Correction

In referring to the rapid hardening cement used in the floors of the Carreras Limited factory building on page 22 of our May issue, ferrocrete cement was mentioned.

Attention has been called to the fact that Tunnelite rapid hardening cement was used. This is a product of the Tunnel Portland Cement Company, Limited, London, England. Tunnelite was also used in the construction of the entire superstructure.

Quantity Surveyors Gather for Third Annual Convention

The American Institute of Quantity Surveyors held their third annual convention at Hotel Pennsylvania in New York, on June 25th, 26th, and 27th.

In the absence of a post-meeting report, reference to the program discloses that among the topics on which addresses were made and discussions took place were methods of surveying concrete, pricing quantities, preliminary estimates, appraisals, uninvited bidders, and unfair competition.

A. R. B. A. 1929 Convention and Road Show; New President

The American Road Builders' Association will hold its 1929 convention and road show in Cleveland, Ohio, during the week of January 14th. Extensive additions to the Cleveland Public Auditorium have been completed and will permit simultaneously a convention and show.

At the annual banquet held in Washington, D. C., on May 11th, Col. R. Keith Compton was installed as president. He had been elected in January and will serve one year. Col. Compton is director of the Richmond, Va., Department of Public Works.

American Concrete Institute Plans for 1929

Announcement has been made that the 25th annual convention of the American Concrete Institute will be held at the Book-Cadillac Hotel, Detroit, Michigan, on Tuesday, Wednesday, and Thursday, February 12th to 14th, 1929.

New Books

CEMENTS, LIMES AND PLASTERS; THEIR MATERIALS, MANUFACTURE AND PROPERTIES, by Edwin C. Eckel, C. E. Third edition. Published by John Wiley & Sons, Inc.

The most interesting feature of this new edition of Eckel's standard work on cements, limes and plasters is the inclusion of considerable material on the new high early strength portland cements which are today being manufactured. Mr. Eckel's treatment of this subject, while not voluminous, is thoroughly up-to-date and written with a great deal of care. He surveys all reliable material available on the subject, and presents what is unquestionably a fair and accurate summary of the existing information to be had regarding these improved cements.

Although Mr. Eckel has handled the matter in as conservative a manner as could be desired, he takes the rather unusual step of venturing a prediction on the last page of his book regarding the future of portland cement. He says:

"As to production, my judgment is that within a few years the ordinary or low strength Portlands will be dropped by progressive companies, and that the engineer will in the near future choose his cement from among three groups: (1) Alumina Cements, made in blast furnaces at or below the present Portland costs, and giving extreme high early strength and high chemical resistance; (2) High Strength Portlands, still made perhaps in the rotary kiln with even higher lime and silica than now current; and (3) some type of Portland-Silica or Portland-Puzzolan mixture, giving better chemical resistance than straight Portlands."

Concrete Resists Sulphate Action

Recent Inspection of a Ten Year Old Reinforced Concrete Reservoir Subjected to Unusual Exposure Shows Concrete Is Unaffected

By DWIGHT F. JENNINGS

THE completion of a new structure is usually the occasion for considerable display of interest in it, particularly if some new or novel engineering features entered the design or construction methods. If the structure continues to function satisfactorily there is a tendency for interest to wane, and for the whole matter to be relegated permanently to the background, notwithstanding the fact that either the design or the materials of construction may have records of performance entitling them to form the basis for future designs of similar projects.

Definite information regarding the condition of a foundation structure after years of service is occasionally made available by the excavation of adjoining property, or regarding the condition of a tunnel lining or canal lining when the necessity for dewatering affords an opportunity for inspecting the otherwise inaccessible surfaces.

Inspection of existing structures not only affords a means of checking their performance but may often show varying conditions differing from those governing the original design. If made at the proper time, a thorough inspection might be instrumental in prolonging the life of the structure, or in preventing a failure.

Concrete Resists Action of Sulphur Compounds

A recent examination of the reinforced concrete reservoir at the waterworks at Dundee, Mich., showed that the quality of the concrete was not affected after ten years of continuous service, although the water supplied by the wells has an unusually high content of sulphates and sulphides.

Close-up view showing a section of the reinforced concrete reservoir in the background

It was found that although there is a tendency for a surface scale to form just above the normal water line, due to the precipitation of salts from the water, the concrete has successfully withstood the action of the sulphate-laden water.

As an indication of the sulphur content of the water it is interesting to note that residents in the immediate locality report that white paint applied on houses on the adjoining property soon becomes discolored due to the action on the white lead pigment by the sulphur gases emanating from the waterworks. Eaves, troughs and gutters on the same houses must be replaced every few years, it is claimed, on account of the destructive action of the sulphur-laden air, and also that it is necessary for the owner to grease all tools before hanging them in an enclosed tool shed to avoid corrosion of the metal parts.

Because of the action of the sulphate-laden water on the interior of the steel tank into which the water is pumped after going through the aerator, it was recently found necessary to clean and reline the metal container, while the concrete structure which is exposed to the more concentrated solution of sulphur salts and fumes has remained unharmed without any surface coating.

Construction Details of Reservoir

The reservoir was built in 1917. In plan it is about 25 ft. by 75 ft. with a capacity of 150,000 gallons. The side walls, 14 ft. high, and bottom are of reinforced concrete. The lower part of the structure is below the finished surface of the ground, as shown in the illustrations.

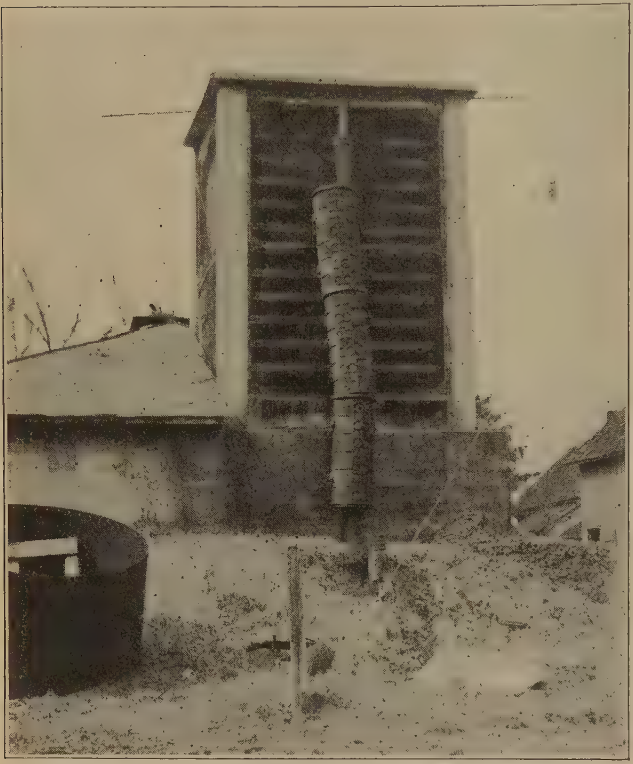
Pump house and reservoir as seen from in front of elevated steel water tank. The lower part of the reservoir is below the surface of the ground

The elevated coke trays, through which the water is aerated before it enters the reservoir, remove a large portion of the sulphides, leaving the sulphate salts in solution. The trays are so constructed as to permit the coke to be readily replaced when necessary.

The specifications under which the reinforced concrete structure was built called for the usual construction methods, "using just enough clear water to form a plastic mixture." The concrete was deposited in layers approximately 1 ft. thick and the coarse aggregate worked back from the surface.

A Dense Concrete Mix

No integral or surface waterproofing was used. A good, dense mix was produced using standard portland cement, bank sand and crushed limestone in sizes from ¼-in. to 1-in., from a nearby quarry. The proportions were 1:1½:3. The small amount of mixing water used and the thorough mixing, together with the care exercised in placing as evidenced by the lack of any honeycombing or laitance seams, resulted in a concrete of sufficient strength and density to resist the chemical action of the sulphur compounds in the water and in the moisture-laden air, as well as the physical action due to repeated freezing and thawing.



End view of reservoir showing coke trays for aerating water as pumped from the wells. Form marks are still plainly visible after years of exposure to the weather

The accompanying table gives reports of chemical analyses by the Michigan Department of Health, and shows the parts per million of various chemicals in the water before and after aeration. The water as it comes from the wells is the highest in sulphur content of any that the engineers in charge of the design and construction have ever endeavored to treat.

REPORTS ON CHEMICAL EXAMINATIONS OF WATER

	At Municipal Well—City Park Parts per Mil.	At Town Pump Parts per Mil.
Solids, total	1577.0	1494.0
Solids, dissolved	1577.0	1379.0
Solids, suspended	———	115.0
SiO_2 (silica)	17.6	17.6
Fe_2O_3	Trace	90.4
Fe	———	63.2
Ca	298.0	247.0
Mg	120.4	92.2
Na + K	10.6	37.2
Cl	21.5	65.0
SO_4	980.0	625.0
OH	———	———
HCO_3	258.0	410.0
Hardness as $CaCO_3$	1237.0	998.0

Construction was by T. C. Brooks & Sons Company, Detroit, Mich. The waterworks system was designed and its construction supervised by George Champe, civil engineer, Toledo, Ohio.

Concrete Scale Platforms Prove Worth

Reinforced concrete scale platforms have gained a good reputation at several locations for continuous daily use weighing heavy wagons and auto trucks. Good examples are those at the Security Bank Building in Minneapolis, in service several years, at the Philadelphia & Reading Coal Company's yard in Minneapolis, installed and in use for 11 years, and those at the City of Minneapolis Park Board Building, built 15 years ago.

These concrete platforms are water-tight, preventing rain water running through and washing dirt into the scale bearings. This serves as an additional protection to the metal parts of the scale under the platform by reducing the causes of corrosion. Further, by keeping surface dirt out of the bearings and away from the knife edges, a common cause of error and inaccurate weights is eliminated. Also, all swelling of the platform, causing binds around the edge in wet weather, is eliminated.

For the base concrete a 1:2:4 mix is used. A top one inch thick is then applied mixed one part cement, two parts clean sharp sand with 100 lbs. of floor hardener to each 100 square feet of platform, and troweled smooth. The surface is scored at frequent intervals in a direction transverse to the direction of traffic across the scale to decrease slipping.

Northwest Products Men Choose High Spot for Meeting

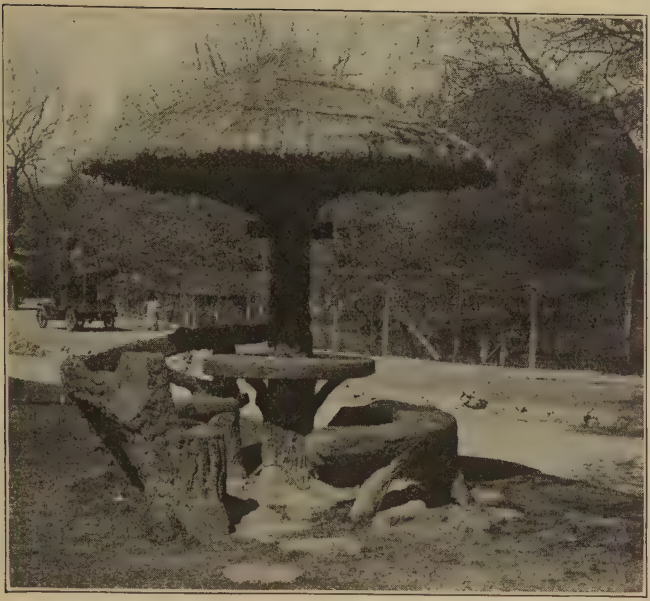
Northwest Concrete Products Association members will trek to Rainier National Park, on Mt. Rainier, for their midsummer convention on July 16th and 17th. As in past years, an invitation to attend is extended to nonmembers.

Edward Warner, manager of the E. W. Harrison Pipe Company, Tacoma, is general chairman of the convention committee.

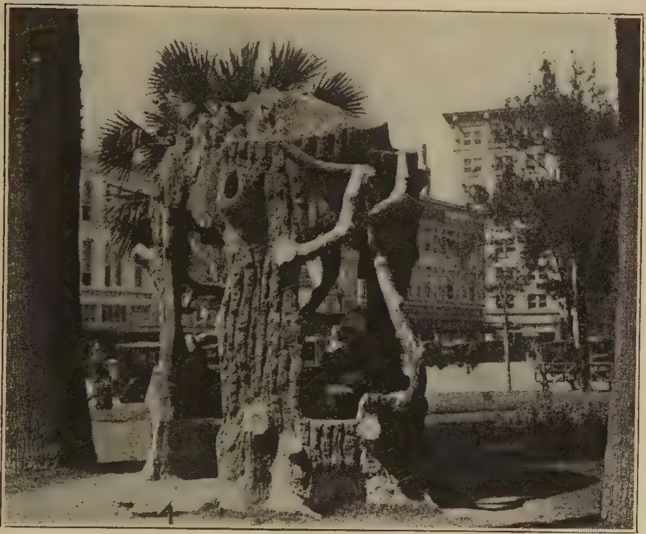
One-half of the entire convention will be under the direction of W. D. M. Allan, manager of the Cement Products Bureau of the Portland Cement Association. Mr. Allan will conduct a demonstration of methods being used successfully throughout the United States in the advertising and selling of concrete products.

Reproducing Nature in Concrete

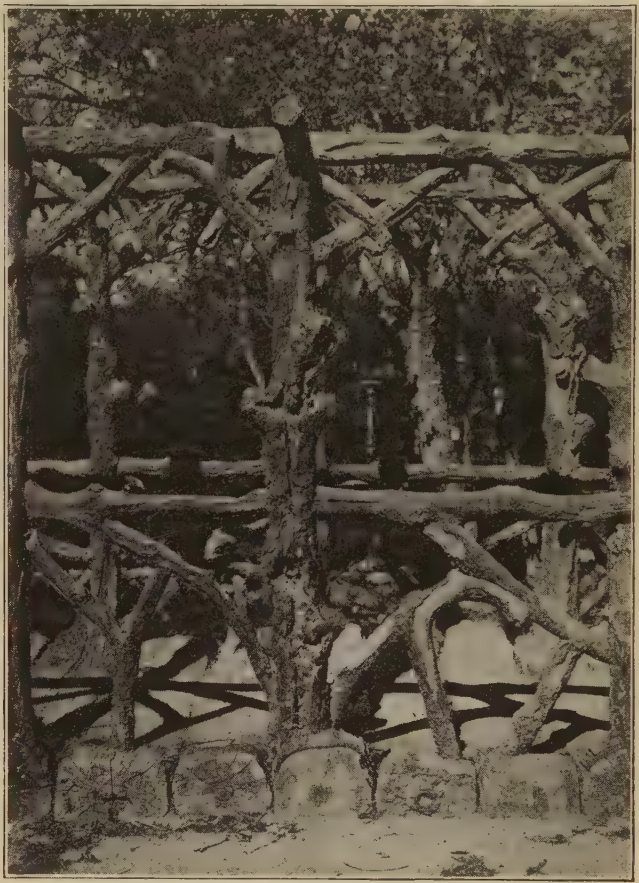
Some Illustrations of True to Nature Modeling in San Antonio, Texas, by Dionicio Rodriguez



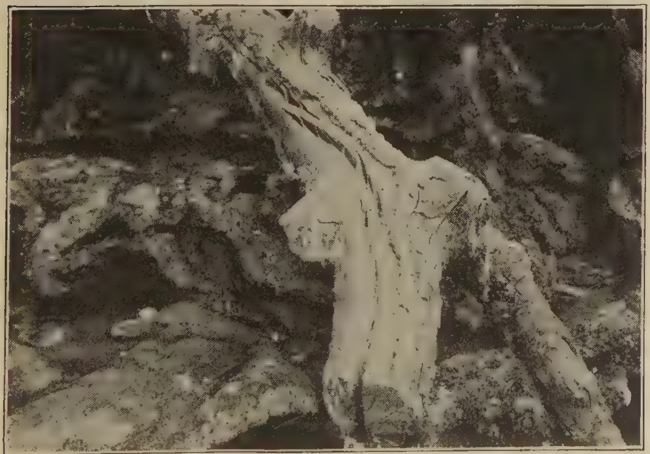
A seat and shelter in Kahler Park. Even the "straw thatched" roof is concrete

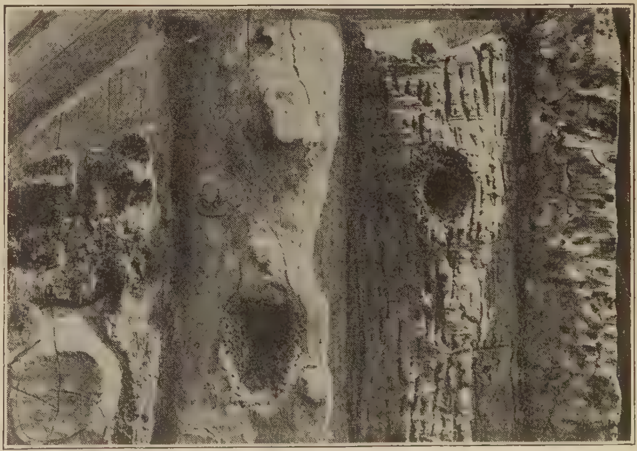


A shelter in the Alamo Plaza. Every piece of bark, every worm hole, every weather check is made by hand before the concrete is colored



A rustic concrete bridge in Breckenridge Park. No forms are used by this artist from Mexico City. Every unit is modelled by hand





The coloring of this work is truly remarkable. On the logs shown in these close-up views, the gray-brown weathered wood is shown where the bark is stripped, and the many tints, shades and textures of the bark and the knot holes are faithfully reproduced

Speed with Economy in High Early Strength Concrete

(Continued from page 16)

main office so that immediate information was available as to the quality of the concrete going into the work.

The most remarkable result from the records kept on this job was the uniformity in weight per cubic foot of the materials as delivered under all variable conditions of grading, etc. The uniformity of the moisture content in the aggregate was also pronounced. It was only necessary to change the setting of the moisture compensator on the concrete strength regulator about once a week, and then only slight amounts. An excess of ½ per cent was allowed for tending to raise the strength of the concrete.

It was noted with interest that even though the fineness modulus or the grading changed, the weight per cubic foot was almost constant throughout the job and it was very seldom necessary to change the weighing hopper due to any change in grading, or due to any change in weight, moisture and bulking.

Compression cylinders were made of each 300 yds. of

TABULATION OF STRENGTH TESTS

Date	Hour	Weather	Moisture in Aggregate %	Wt. Aggregate Lbs. Per Cu. Ft.	Average Fineness Modulus	Bulk Ratio	No. of Cylinders	Curing Conditions	Average 3-Day Strength	Average 4-Day Strength	Average 7-Day Strength	Equiv. 28-Day	Average Actual 28-Day	Estimated 90 Days
3-16	9:00 A.M.	Fair	2.5	Sand—107			5 from slab	Outdoors*			1060	2040		2650
	11:00 A.M.	Fair	3.3	Gravel—115										
	2:00 P.M.	Fair	2.8	Mix—124	5.56	1.10								
3-19	9:00 A.M.	Fair	3.4	Sand—108			3 from slab	Outdoors	601			2220	2230	2890
	11:00 A.M.	Fair	3.3	Gravel—113										
	2:00 P.M.	Fair	4.1	Mix—123	5.40	1.10								
3-22	9:00 A.M.	Rain	3.3	Sand—106			8 from slab	Outdoors	540					
	11:00 A.M.	Rain	3.3	Gravel—112				Inside†		1057	1500			
		Rain		Mix—119	5.07	1.08								
3-23	9:00 A.M.	Fair	2.1	Sand—109			4 from slab	Standard					2245	2920
	11:00 A.M.	Fair	2.6	Gravel—115				Inside		1126				
	2:00 P.M.	Fair	1.8	Mix—126	5.26	1.12								
3-28	9:00 A.M.	Fair	2.6	Sand—109			4 from basement wall	Outdoors			1302	2385	2945	3820
	11:00 A.M.	Fair	1.5	Gravel—114										
	2:00 P.M.	Fair	2.4	Mix—127	5.34	1.09	13 from slab	Outdoors	645					
4- 2	9:00 A.M.	Fair	3.5	Sand—106				Inside		1065				
	11:00 A.M.	Fair	2.5	Gravel—111				Standard			1306	2392	2590	3140
	2:00 P.M.	Fair	3.1	Mix—122	5.42	1.12								
4- 4	9:00 A.M.	Fair	3.0	Sand—110			From slab	Inside	1235					
	11:00 A.M.	Fair	3.0	Gravel—112				Standard					2460	3200
	2:00 P.M.	Fair	2.9	Mix—124	5.18	1.11	4 from column	Standard			1870	3160	2605	3390
4- 7	9:00 A.M.	Fair	4.1	Sand—109			10 from slab	Outdoors	824					
	11:00 A.M.	Fair	3.9	Gravel—114				Standard			1322	2412		3140
	2:00 P.M.	Fair		Mix—124	5.15	1.10								
4-11	9:00 A.M.	Fair	3.7	Sand—108			12 from slab	Standard			1610	2810	2640	3430
	11:00 A.M.	Fair	3.4	Gravel—113				Outdoors	652					
	2:00 P.M.	Fair		Mix—125	5.18	1.12								
4-18	9:00 A.M.	Fair	3.8	Sand—111			9 from slab	Standard			1100	2095	2297	2990
	11:00 A.M.	Fair	3.6	Gravel—112			6 from column	Standard					2390	3110
	2:00 P.M.	Fair	4.3	Mix—127	5.70	1.14								
4-26	9:00 A.M.	Fair	3.6	Sand—108			4 from wall	Standard					3130	4070
	11:00 A.M.	Fair	3.5	Gravel—111			3 from column	Standard					3110	4050
	2:00 P.M.	Fair	4.1	Mix—126	5.25	1.15	7 from slab	Standard					2750	3570
5- 2	9:00 A.M.	Fair	3.7	Sand—108			10 from slab	Standard			1760	3020	2835	3680
	11:00 A.M.	Fair	3.2	Gravel—111			6 from column	Standard			2180*	3580*	2660	3460
	2:00 P.M.	Fair	3.3	Mix—127	5.47	1.17								
5- 7	9:00 A.M.	Fair	3.7	Sand—108			9 from slab	Standard			1560	2750	2510	3260
	11:00 A.M.	Fair	3.8	Gravel—111			4 from wall	Standard			1610	2810	2310	3000
	2:00 P.M.	Fair	3.7	Mix—127	4.92	1.15								
5- 8	9:00 A.M.	Fair	4.5	Sand—108										
	11:00 A.M.	Fair	3.8	Gravel—111			10 from slab	Standard			1370	2480	2210	2880
	2:00 P.M.	Fair	3.6	Mix—127	5.31	1.16								
5-17	9:00 A.M.	Fair	2.4	Sand—106			6 from column	Standard			2080	3450		4470
	11:00 A.M.	Fair	2.7	Gravel—109			2 from roof	Standard			1695	2930		3810
	2:00 P.M.	Fair	2.7	Mix—126	5.40	1.18								
5-21	9:00 A.M.	Cloudy	Our Stock—3.0				3 from slab	Standard				2250		2925
		Following	Hunters—2.9	Sand—108										
			Truck—3.4											
	11:00 A.M.	Heavy Rain	Hunters—3.4											
			Truck—3.4	Gravel—113										
	2:00 P.M.		Hunters—5.3											
			Truck—5.2	Mix—125	5.09	1.13								
5-22	8:30 A.M.	Cloudy	Truck—5.0	Sand—108										
		Damp					3 from column	Standard			1760	3020		3930
	10:00 A.M.	Damp	Hunters—4.6	Gravel—112										
	11:30 A.M.	Damp	Truck—4.9	Mix—126	5.20	1.07								
5-23	8:30 A.M.	Fair	Truck—4.1	Sand—108			3 from slab	Standard			1630	2835		3680
	9:30 A.M.	Fair	Hunters—4.0	Gravel—112										
	10:00 A.M.	Fair	Truck—3.5	Mix—125	5.14	1.12								
5-25	9:00 A.M.	Fair	Truck—3.9				3 from slab	Standard			1870	3170		4120
			Hunters—3.5	Sand—107										
	10:30 A.M.	Fair	Truck—3.7											
			Hunters—3.6	Gravel—111										
	11:30 A.M.	Fair	Truck—3.5	Mix—124	5.29	1.10								

*Exposed to natural atmospheric conditions. †Cured within winter protection.

concrete poured and most of these were exposed to the same conditions as the concrete in the structure. This was done because it was of greatest interest to know the condition of the concrete in the structure. It was found desirable to place some of these cylinders under the slab exposed to the heat of the salamanders; and to place some on top of the floor slab under the covering, but not directly exposed to the salamanders. The difference in strength was noted and the average of the two assumed to be the condition of the strength of the concrete in the slab proper. Some of the cylinders were cured under standard conditions and broken as a matter of comparative record. Some cores inserted directly in the slab and removed later for compression test showed a strength of from 2200 to 2500 lbs. per sq. in. at 28 days.

A job curve was plotted early in the work, using information obtained from similar concrete placed elsewhere. It was known that a water-cement ratio of "one" would give an average strength of not less than 2200 lbs. As a matter of fact, the average of all 4-day cylinders was 992 lbs. per sq. in.; the average of all 7-day cylinders was 1420 lbs. per sq. in., giving an estimated and checked average of strength at 28 days of 2550 lbs. per sq. in., all for water-cement ratio of .95. (Note from the table that on certain days the average 4-day strengths ran as high as 1126 lbs. per sq. in.)

Some interesting cost data is that of the floor finish. The cost of this floor finish for labor was $.036 per sq. ft., for the material $.009 per sq. ft.

The covering on the top of the slab was kept at a height of 6 ft. above the floor inasmuch as monolithic floor finish was placed with the slab. This floor finish consisted of iron filings (30 lbs. per 100 sq. ft.) placed under the standard methods with a mixture of sand and cement put on the concrete slab immediately after screeding off. Because concrete of a very firm consistency and minimum of water content was used, there was very little excess of water coming to the surface of the slab and preliminary floating could usually be started within two hours of the pouring of the concrete.

The interior of the building after completion

Only One Set of Forms Used

It was decided that it was safe to remove forms when the compressive strength of the concrete showed 600 lbs. or over per sq. in. at the time of removal of forms. This was a safe assumption as the water-cement ratio had been kept constant in the concrete strength regulator and all the concrete was known to be uniform and of the same strength within a day's work. As the concrete was designed for not more than 600 lbs. per sq. in. under both live- and dead-loads, it was therefore safe to remove the forms at any time when this strength was obtained because the concrete had only its own dead-load to carry and reshores of 6 by 6's were placed centrally between columns and in the center of every bay.

When the weather was very cool and it was desirable to have the finish set up early, calcium chloride was used in the upper parts of the concrete slab and concrete specimens made from this were checked with the standard cylinders.

Forms were consistently removed at four days and a floor was ready to concrete within a week after the previous pour.

The forms were kept constantly wetted with a hose and the concrete thoroughly rammed and rodded into place. There were very few honeycombs and pores evident on removal of the forms. The water sprayed on the forms helped to form a thin coat of mortar giving a very good finish to the ceiling.

The consistency of the concrete on delivery in the forms was that of a good rich oatmeal. The men and the foremen soon became accustomed to using concrete of this consistency and workability and rather liked it after they became used to it. In the bottom of all columns and in deep beams, concrete of a higher workability and a greater slump was used. This was accomplished by merely adding another bag of cement in the concrete strength regulator, automatically giving an additional amount of water-cement paste in each batch, without increasing the strength or affecting the setting of the control system.

The entire job was enclosed with a canvas covering. Average temperatures of 70 degrees were tried for the first four days. A watchman was supplied with a time clock to go around and visit the various thermometers and assurance was therefore had that the temperatures were being watched.

No lack of attention was given to the daily control for economy. This was emphasized by making a report each day on the factors entering into the cost of the concrete. These factors were computed from the amount of aggregate and cement used daily, and also the labor cost of the concrete. As these factors varied up or down, immediate attention was called to the grading of the aggregate, or the workability of the concrete as placed and the superintendent could constantly control the cost of the concrete.

In order to judge the economy of control the following summary was compiled:

COST—		
Engineering for testing	$ 520.00	
Cylinders	375.00	
Control (weighing hopper, etc.)	450.00	
Equipment, scales, moulds	25.00	
Concrete strength regulator	600.00	
		$1970.00
SAVING—		
Time of job cut by two weeks, overhead less by	$3000.00	
Increase aggregate yield	900.00	
Increase cement yield	1387.00	
		5287.00
Net saving		$3317.00

COST OF CONCRETE BY MONTHS

MARCH—1928

Location	Total Yards	Labor	Cost of Aggregate	Cost of Cement	Total Cost
Slab	2300	$0.91	$2.51	$2.64	$6.06
Column	260	1.38	2.48	3.16	7.02

APRIL—1928

Location	Total Yards	Labor	Cost of Aggregate	Cost of Cement	Total Cost
Slab	2280	$0.84	$2.48	$2.94	$6.26
Column	316	1.02	2.54	3.78	7.34
Wall	114	1.02	2.54	3.36	6.92

MAY—1928

Location	Total Yards	Labor	Cost of Aggregate	Cost of Cement	Total Cost
Slab	1274	$0.71	$2.39	$2.82	$5.92
Column	210	1.34	2.74	3.66	7.74
Wall	271	1.45	2.55	2.85	6.85

Note: The above values represent the average cost per yard.

SUMMARY OF CONCRETE POURED AND AGGREGATE OF CEMENT CONSUMPTION

	Yards
Exterior columns	696
Interior columns	828
Beams	222
Slabs	6749
Sills	31
Walls	378
Roof	57
Pile caps	614
Total yards	9575

Barrels of cement used	13,350
Cubic yards of mix used	10,140
Aggregate factor (actual)	1.06
Aggregate factor (estimated)	1.10
Difference	0.04
Cement factor (actual)	1.394
Cement factor (estimated)	1.463
Difference	0.069

Aggregate saving—
$2.35 × 9575 × .04 equals $ 900.00
Cement saving—
$2.10 × 9575 × .069 equals $1387.00

Total saving $2287.00

From all of the above it is very evident that there is absolute assurance of the strength of the concrete in this structure. In fact if the concrete increased in strength as indicated in Figure 5, page 7, of the Portland Cement Association bulletin, "Design and Control of Concrete Mixtures," we may expect an average strength of this concrete in 90 days of 3270 lbs. per sq. in., and in one year of 3920 lbs. per sq. in.

If, therefore, the engineering and construction industry is willing to accept and adopt the proposed Standard Building Code submitted at the convention of the American Concrete Institute in Philadelphia in February, and base the design of concrete structures on such tables as submitted at the same convention by Arthur R. Lord, there would be a saving in the cost of this structure in accordance with Figure 18 on page 112 of Mr. Lord's paper, of five cents a sq. ft. or on 230,000 sq. ft., $11,500.00.

Conclusions

In this operation there was an evident gain by taking advantage of the knowledge of available control methods in the speeding up of the job and thereby giving the owners earlier occupancy and reducing the overhead cost of the work. But it is not unreasonable to expect that in future years the further economy that is available for the industry will also be taken advantage of in designing the structure in such a way as to take advantage of the assurance of the higher crushing resistance of the concrete with a 1:2:4 mix when a lower water-ratio is used.

The conclusions from this operation can be briefly stated as follows:

(a) Assurance of the quality of the concrete is best obtained by weighing the water, cement and aggregates.
(b) Weighing aggregates eliminates variation in bulking and grading.
(c) Weighing aggreates gives simple check on moisture content.
(d) Moisture variation in aggregates is negligible.
(e) Weighing water against cement simplifies control of water-cement ratio.
(f) Compressive strength of 2300 lbs. per sq. in. with water-cement ratio of 1.00 can be expected from 1:2:4 concrete in New York City.
(g) Control methods pay for themselves even though increased strength is not taken advantage of in design.
(h) The concrete industry can safely adopt the proposed American Concrete Institute Building Code and Standard Designs.

20-Hour Pavement Laid to Presidential Quarters in Wisconsin

Twenty hours for the opening of concrete pavement to traffic was the new record established on a highway between Brule and Superior, Wisconsin, recently.

The decision to use high early strength concrete was made at 9 o'clock in the evening of June 4th. By 7 the next morning, state engineers had staked out the project and forms were set by noon. At 9 p. m. the last of the concrete was placed, and the next afternoon at 5, just 20 hours after placing the concrete, the road was opened to traffic. Laboratory tests showed concrete having a compressive strength of over 2000 pounds per square inch in 20 hours.

The sudden decision on the part of President Coolidge to spend his summer vacation at Brule presented the opportunity for Wisconsin highway engineers to establish what is believed to be a new record.

U. S. Highway No. 2, between Brule, the summer "white house," and Superior, where the President maintains executive offices, was particularly ordered for speedy repairs because this road would bear the heaviest traffic.

An unpaved strip near Amnicon Falls, just beyond the end of the concrete pavement placed last fall, was in bad condition. In both locations high early strength concrete was given the preference over temporary surfacing.

Col. E. W. Starling, White House representative, W. C. Bowtow, J. R. McLean, H. F. Holmes and Roy Risberg, all of the State Highway Department, were associated in planning and executing the work. A. N. Nelson, Duluth, Minn., was the contractor.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

Twenty-fifth annual convention, Book-Cadillac hotel, Detroit, Mich., Feb. 12th to 14th.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

1929 convention and road show, Cleveland, Ohio, Jan. 14th to 19th.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; Wharton Clay, Commissioner, 123 W. Madison St., Chicago.

Association of Cast Stone Manufacturers; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Products Association; F. O. Matthiessen, Secretary, 644 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Iowa Concrete Products Association; Geo. T. Wilhelm, President; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President; A. W. Dickson, Executive Secretary, 2226 Builders Building, Chicago, Ill.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 E. Twenty-second St., New York City.

The National Lime Association; G. B. Arthur, Secretary, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; E. B. Bushnell, Secretary-Treasurer, 425 E. Water St., Milwaukee, Wisconsin.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

CONCRETE has been successful in securing from the flourishing pen of Charles E. Babbs, after many efforts, the following contribution, fit to rank as an epic in its class of literature.

Mr. Babbs is CONCRETE's youngest contributor in point of age and is an invaluable member of the office boy staff of the Portland Cement Association main office.

The Three Little Pigs—A Concrete Fairy Tale

By CHARLES E. BABBS

I.

THREE little pigs were leaving their mother to make their way alone in the world. Their mother, who was exceedingly wise, told them to build a very strong house and settle down. So they bade their mother good-bye and journeyed in three different directions.

The first little pig, a black one, met a farmer who was trying to sell a wagonload of lumber. Little Blackie purchased the lumber and built a frame house for himself. One day Blackie was interrupted while doing his black-bottom lessons by a loud growl. Looking out the window he beheld a huge, hungry wolf. "Let me in," said the wolf. The little pig refused. So the wolf said, "If you don't let me in, I will destroy your house!" Blackie believed this impossible, so he told the wolf to do his worst. The wolf set the frame house on fire and out ran Blackie. And that, friends, was the sad ending of Blackie, the first little pig to leave home.

II.

The second little pig, Brownie, was walking along the road, reading a paper. He stopped, he stared, and thought very hard: The advertisement read, "Brick for Sale—Cheap." Now he could build a house that would not burn down. So he bought enough brick to construct his house.

Brownie was enjoying a swim (for he had a concrete pool in his basement) when he heard with terror, a loud knocking at his front door. He hastily went to the door and questioned in a quavering voice, "Who's there?" "It is I," said the wolf, "let me in!" But the frightened Brownie was suspicious and refused to let the wolf in. "I'll blow your house down," cried the wolf. So he blew and blew and blew and finally the house crumbled and toppled over.

III.

And the third little pig met a man with a truckload of concrete masonry units. "Please, sir," said the little pig, "how much for the whole load of concrete blocks?" The man named his price, and the little pig, pleased at such a fine bargain, bought the load of concrete masonry units.

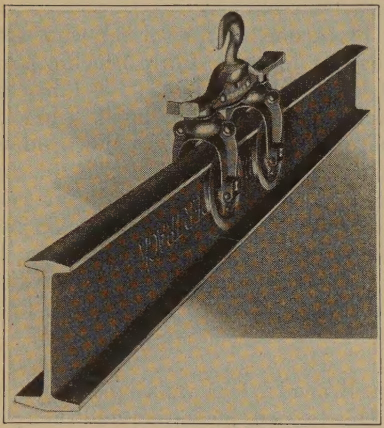
One day the wolf came along. Looking in the window he saw the happy little pig in his snug, warm home, sweeping the concrete first floor. "Let me come in," cried the wolf. "I'm not as dumb as I look," said the little pig, turning on the radio to drown out the wolf's voice. "Then I'll huff, and I'll puff, and I'll blow your house down," threatened the wolf. "Go ahead, and see how far you get," said the smart little pig. So the wolf huffed, and he puffed, and he puffed and he huffed, and doggoned if he COULD blow the house down, for, you see, it was built of those fine, strong concrete masonry units which the little pig had purchased. "Ha, ha!" laughed the little pig merrily, "concrete is fireproof and dampproof, hurricane-proof, and now I find it's proof against hot air!"

Joe, the Mixer Boss.

New Equipment and Materials

"Super-Track" Conveying Equipment Adds to Capacity of Overhead Equipment

The Louden Machinery Company, Fairfield, Iowa, has developed and is now marketing "Super-track" monorail conveying equipment, which is a heavy type with a carrying capacity rated as 3,000 lbs., including a large margin of safety.



This overhead trolley track, the manufacturers say, is a special section, permitting heavier loads and at the same time eliminating to a great extent, the necessity of supporting superstructure. Hangers may be widely spaced, simplifying the spanning of wide areas between roof trusses.

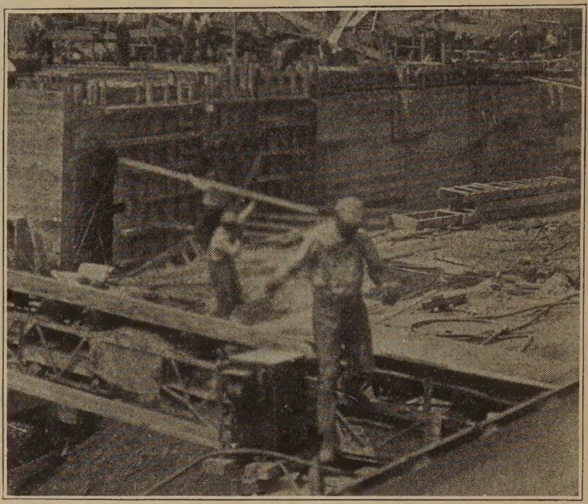
Super-Track may be used alone or in conjunction with the lighter Louden double bead monorail, it is said.

Barber-Greene Hopper for Portable Belt Conveyor

To the right in the illustration is seen a hopper for the purpose of serving portable belt conveyors to best advantage. According to the manufacturer, the hopper proper is narrower than the standard type and higher, to provide for volume loads. It is designed at the same time to center the wet concrete so that it will flow off the belt farther up on the conveyor.

The hopper, it is said, is especially heavy to withstand excessive load. The tail pulley is larger and heavier than the standard hopper of this make, providing better traction for the belt and transmission of the load throughout the upper frame.

The Barber-Greene Company, Aurora, Ill., manufactures the hopper.

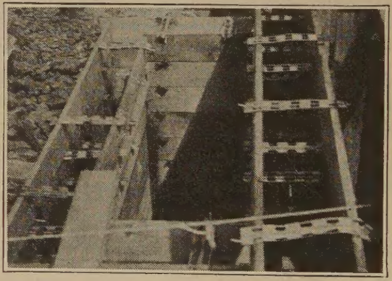


"Form-Hold" Device Effects Saving in Form Costs

"Form-Holds" are metal ties and spacers crimped slightly when being installed, as illustrated, and clipped off level with the concrete with an ordinary tool when forms are removed.

The device is designed to resist both compressive and tensile pressures and to effect a saving of more than 50 per cent in the number of studs used, since one side of the line wall is said to require no studs and the other but half the number commonly used.

In installing, "Form-Holds" are placed over the board, crimped somewhat, and topped by the next board and so on to the proper height. A form board is then inserted under the outside ends of one row of "Form-Holds" and the board shoved in position, followed by the balance of the boards on the side of the form opposite the line wall.



Upon completion of the wall and setting of the concrete, the outside ends of one row of forms are bent up and the boards slid out one by one.

In hollow wall construction "Form-Holds" are laid zig-zag so that they do not extend entirely through the wall. The inside boards of the form are left in the wall.

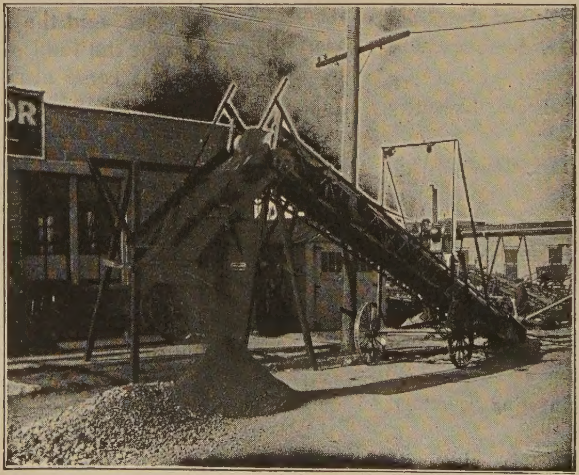
The Concrete "Form-Hold" Corporation, Culver City, Calif., is the manufacturer.

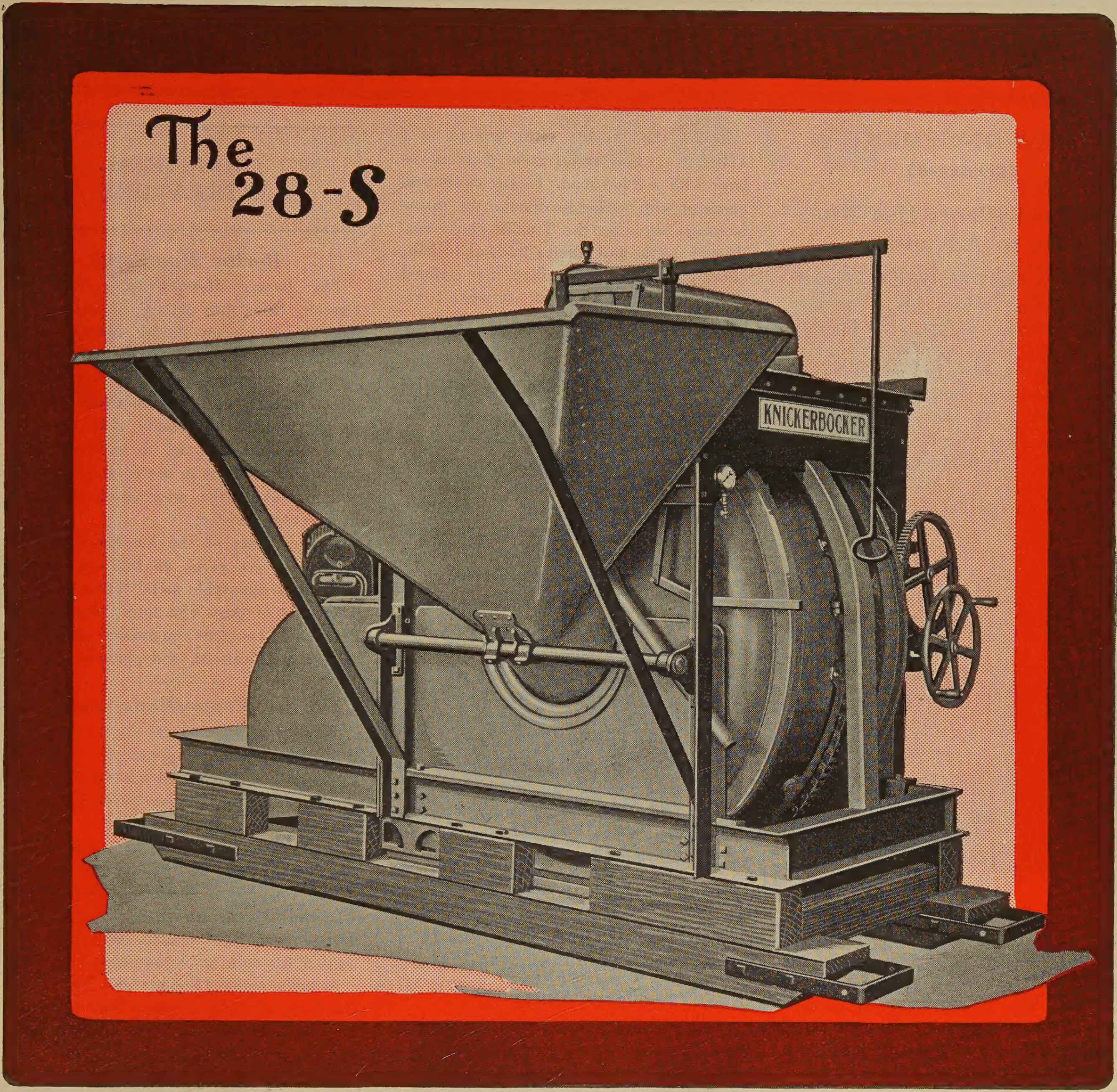
Northern Conveyor Patents Combined Screening Plant

The Northern Conveyor and Manufacturing Company, Janesville, Wisconsin, has been successful in securing a patent on a complete portable loading and screening plant. This equipment combines the use of shaker screens and portable conveyors.

The Northern Conveyor company lays claim to the title of pioneer in this type of plant, having projected it a number of years ago.

The accompanying illustration shows the equipment in operation.





THE high-drum accommodates large openings. That means fast charging, quick discharge—handling sticky concrete rapidly and efficiently. Built close to the ground, Knickerbockers need no props—they have *stability.*

Built in all sizes 5-S to 28-S
inclusive by

THE KNICKERBOCKER COMPANY, JACKSON, MICHIGAN

KNICKERBOCKER
CONCRETE MIXERS

FOR SUCCESSFUL PERFORMANCE · A.G.C.·A ·

(809)

About Makers of Equipment and Materials

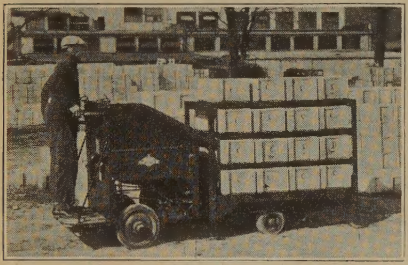
NEW EQUIPMENT

(Continued)

Products Plants Use Truclift to Advantage

A new method of handling concrete products on racks has been in operation for some time in the plant of the Economy Concrete Products Co., Wauwatosa, Wis. The Economy plant is laid out in modern fashion with paved runways in the storage yard. Tracks have been eliminated and kilns are emptied with the aid of a gasoline-powered lift truck, the platform of which is slipped under the loaded rack. The truck operator applies power which lifts the platform until the legs of the rack have ample clearance from the floor and then conveys the loaded rack to the yard.

Jake Golden, of Hammond, Ind., is said to use a similar truck. Mr. Golden has a daily output of 3200 plain blocks. He employs a Clark Truclift, like that used in the Economy plant, for taking racks loaded with green blocks from the machines to the kiln. The Truclift operator unloads the kilns, taking the 64 racks of cured blocks to the yard and brings them, after being unloaded, around to the machines again.



The Truclift is manufactured by the Clark Tructractor Co., Battle Creek, Mich., and is distributed in the concrete products industry by the Consolidated Concrete Machinery Corporation, Adrian, Mich. A new model just introduced is similar in most respects to the Truclifts used in the Wauwatosa and Hammond plants except for an important improvement in construction, designed to meet the particular need of the concrete products manufacturer.

This involves a construction by which the platform is suspended on coil springs held in tension, eliminating all jar even when the Truclift has uneven going. This is especially important when green products form the load. Four resilient soft rubber insulators absorb the shock should the operator accidently bump the racks when picking them up.

The Clark Truclift turns around in a 11½-foot radius and travels 6 miles an hour with a 2-ton load. Clutch equipment operates with such smoothness, the manufacturers say, that the Truclift starts easily and gently and carries its load without vibration. Driven by gasoline, it is claimed to be capable of 24-hour service if required.

Facility of Paint Spraying

The Alexander Milburn Company, Baltimore, Maryland, has lately made two improvements of interest which have resulted in the issuance of a new paint spray gun, Type EF. According to the manufacturer, the new dialed head gives numerous types of spray adjustments, from a circular spray to a fan of an increased field.

The second improvement, according to an announcement made, is a series of indicator numerals on the paint valve plunger. A pointer is operated as the operator turns the adjustment button. The numerals are designed to provide the exact volume desired without the necessity of losing time by testing. The operator, having found that a certain class of work is best performed when the indicator points to a certain figure, makes the proper adjustment before spraying.

Notes from the Field

Mixer Merger

H. B. Lichty, president of the *Construction Machinery Company*, Waterloo, Iowa, has announced the merger of the *Marsh-Capron Company* with the former.

The change, it is said, has been brought about chiefly on account of the economies of common management rather than for the purpose of eliminating either organization. All equipment is to be continued as in the past. The sales and service policies of both firms will be retained as they are.

One of the advantages effected by the consolidation is the ability to manufacture a complete line of tilting and non-tilting equipment under a single executive organization.

Mr. H. M. Capron, who organized the original *Marsh-Capron Company*, will be chairman of the board of directors.

The Construction Machinery Company was organized in 1909 by Mr. Lichty as the Waterloo Cement Machinery Company, and has manufactured the line of Wonder tilting mixers.

INDUSTRIAL LITERATURE

Berloy Handbook

The Berger Manufacturing Company, Canton, Ohio, has issued recently a 96-page handbook on *Berloy* concrete form construction equipment relating particularly to concrete floors. Inspection discloses that no little attention was paid in its compilation to details that the concretor is interested in, to securing illustrations of products in use from all aspects, and to making the information contained in it comprehensive.

The contents of the handbook are divided into six parts, as follows: permanent cores, removable metal forms, common properties of cores and forms, engineering data and concrete quantities and load tables, specifications, and pictorial section.

Coloring Proportions and Cost

What is perhaps one of the most helpful little publications prepared by manufacturers is that entitled *"Artistic Walks"* and coming from the *Tamms Silica Company*, Chicago.

In it is found the topping requirement for such surfaces as driveways, floors, and porches, figured on the basis of 100 square feet and thicknesses of ½, ¾ and 1 in. The proportions of cement, sand and color needed for each thickness are given.

A table under "Figures and Facts," on the basis of ½-in. topping, lists the color desired, type to be used, amount in pounds, and the total cost of color.

Colored Toxmix

A loose leaf specification covering *R. I. W.* colored *Toxmix* has been published by *Toch Brothers*, New York City. In colored form the material is furnished as powder, in packages containing the exact amount required for a bag of cement.

According to the manufacturers, tests made by independent laboratories as well as their own, show that a considerable increase is secured in both compressive and tensile strength.

Celite Mixes

Bulletin 337 is a new specification sheet published by the *Celite Products Company* and covering the use of *Celite* in concrete. Directions are given for the use of *Celite* in mixes. Included is a discussion of the water-cement ratio as applied to *Celite* mixes.